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Railroad Matters

ALREADY there are indications that the prediction in the Engineering Record last week that the railroad investigation would be momentous are to be realized. But the congressional investigation, apparently, will not be allowed to absorb all of the time that the public can give to railroad matters. The carriers have instituted numerous actions to test the constitutionality of the eight-hour law, while the brotherhoods have made affiliations with certain of the unions of railroad employees, so that instead of 400,000 standing for the so-called eight-hour day, there will be 700,000. There is no need of counsel to follow railroad matters closely in the next few months. The newspaper reading public will not be able to escape from their consideration. As never before, railroad management, railroad regulation, railroad ownership have become national questions.

Exercising One's Influence

ELSEWHERE in these pages will be found an editorial on appropriations for the Bureau of Standards. Those in sympathy with the views there expressed should write to their congressmen expressing the same views or sending a copy of the editorial together with a letter indorsing the position taken. With few exceptions, the members of Congress have little knowledge on scientific subjects and unless their constituents advise them as to their position they have no means of judging of the importance of matters before them other than the statements of the officials requesting the appropriation. If every engineer and manufacturer who is benefited by the bureau's work would put his ideas before his congressman or before the appropriate congressional subcommittee, the bureau could get anything, within reason, that it desired. Besides writing to one's own representative, it would be well if communications were also addressed to John J. Fitzgerald, chairman of the House Appropriations Committee, and to Joseph W. Byrns, chairman of the subcommittee which passes upon the requests of the Bureau of Standards. Additional copies of the Engineering Record will be sent to those who desire to cut out the editorial referred to and send it to Washington.

An Accomplishment

IF permanent construction had been a prerequisite of the West Okanogan irrigation project the system would never have been built. That, in brief, indicates the policy of the financiers of that irrigation district. They wanted to have an irrigation system. They wanted to prevent land speculation. They wanted action. They succeeded in each of these objects. The project, which is the subject of the leading article in this issue, was laid out and completed within a year. The funds available were known. Six hundred thousand dollars was the limit of construction cost. But limiting the expenditure did not cause the details to be slighted. On the contrary, the best efforts of the engineers were directed toward conservation of head and minimum leakage and toward permanent construction where it would have been wasteful to adopt any other kind. The landowner's interests were safeguarded, speculation was prevented and a healthy if slow growth assured.

New Influence Line Methods

EXTENDING in range and detail the field of the newer graphic methods of drawing influence lines and solving indeterminate structures, D. B. Steinman in this issue, page 648, contributes a most interesting series of examples of the use of deflection diagrams as influence lines. In fact, the idea of the identity between influence lines and deflection diagrams will undoubtedly tend to simplify the construction of influence lines, particularly for engineering students. The applications given by Mr. Steinman to illustrate the feasibility and advantages of the method are quite striking. Influence lines for reactions, shears and bending moments in simple beams, for stresses in the members of a simple truss, for cantilever spans, for a two-hinged portal frame and for continuous and fixed-end beams are presented. Both practising engineers and teachers will find his discussion illuminating.

The Writing Season

DURING the spring and summer months, when the season's work is being laid out and executed, engineers and contractors have little time for anything except the immediate business in hand. Even during the winter months, of course, there is work to be done, but seldom is it as pressing as the tasks that fill the spring and the summer days. This, then, is the season that is most likely to afford opportunity for putting on paper the experiences gained during the past eight or nine months. If not reduced to writing now, when they are in mind, they are likely never to find a permanent record and both engineering and contracting will thereby suffer a permanent loss. It is strange that those who, week by week, follow technical developments through the pages of engineering and construction magazines often are averse to recording their own experience through the same mediums. They do not remember that if everyone took the same attitude as they do, technical journals would be impossible and the world's progress would be much slower. This is the writing season. If you have had interesting experiences during the season now closing, make your record now. Engineers and contractors will be your debtors.

Hiding Their Light

THE PRECEDING PARAGRAPH, suggesting that this is the writing season, brings to mind recent correspondence with an engineer having a large practice among small municipalities and in private projects of moderate size. He protested that there was little in his experience that would be of interest to other engineers, remarking that "he seldom did monumental work." Engineers, by and large, however, are not looking for descriptions of monumental work so keenly as they are for ideas which can be applied in their own work. The small commonplace thing is done a hundred times where the spectacular or monumental job is done once. Judged by the ratio of use, therefore, the small item, the "kink," is a hundred times more serviceable to the readers of engineering journals than is a striking feature of the Catskill Aqueduct or the Panama Canal. We do not mean to decry the importance of the major work, but merely to remind engineers who deal habitually with smaller installations that their ideas, by repetition, have an importance far beyond the measuring stick of the cost on a single installation. Here and there about the country are hundreds upon hundreds good ideas that would aggregate large savings, if only those who are responsible for the ideas would realize their news value. The material appearing in the "Hints for the Contractor" section of the Engineering Record is proof that even on the smallest job there are features that merit discussion. May we suggest that each reader engaged on small work look at his job from this angle and say whether or not there are departures from customary practice? If the answer is in the affirmative, put the experience on paper, and "do it now."

Utility Development

THAT the public is the finally responsible party in utility development was admirably set forth by Mayor James M. Curley of Boston at a recent hearing upon the revenue requirements of the Boston Elevated Railway. The chief executive of the Massachusetts capital delivered a courageous address to the effect that if the company demonstrates that it is being economically managed relief should be recommended to the incoming Legislature, preferably along the lines of reduced taxation rather than of fare increase. In some quarters the idea is held that if a public utility cannot afford to embark upon a further extension of facilities of costly character at a given period, the public should be expected to await more prosperous times before such facilities are undertaken. This viewpoint, the mayor demonstrated, is mistaken. In the last analysis it must be the public and the public alone which meets the cost of any given service, including all charges connected therewith, and therefore the public is the rightful decider as to what supernormal extensions shall be undertaken, with the single proviso that the public must always stand ready to meet the fair cost of such facilities. This is a very important truth. Possibly it may appear self-evident to some people, but in view of Mr. Curley's straightforward utterance in the Boston Elevated investigation, it deserves emphasis at this time. If the general public desires a service and is willing to pay its cost, then the economic justification for these facilities becomes a purely academic question. The utility management has done its duty when it has acquainted the public with the cost of the proposed facilities.

Industrial Conference Board

ANNOUNCEMENT was made in New York last week that there has been formed for the consideration of labor problems the National Industrial Conference Board, representing twelve of the large associations of manufacturers. Unfortunately, the newspaper publicity which followed the announcement gave a very misleading impression of the purpose of the board. It was represented to be a movement to fight labor. This is farthest from the minds of those who are responsible for the movement. They realize keenly that warlike methods in dealing with labor are not only obsolete but are attended by grave dangers. Their proposal is to lay before the country the true facts regarding labor difficulties and also to bring about the adoption of fundamentally sound labor policies in the industries represented in the several associations having affiliations with the board. In other words, the constructive activities are to be given major emphasis, while the other line of action will be to lay before the public the true facts when controversies actually arise. The Engineering Record believes that the management of the board is in the hands of those who will face conditions as they find them and who will not hesitate to suggest remedies that are correct even though counter to the wishes of those manufacturers whose indifference and lack of true insight into the nature of our labor problems have brought us to the present condition. It will need courage to take such a stand, but only such a stand can result in a real solution.

Grade-Crossing Protection

RECOMMENDATIONS looking to a standardization of grade-crossing signs and other protection throughout the United States were presented at the annual convention in Washington last week of the National Association of Railway Commissioners. These include a standard warning sign at least 300 ft. from the crossing in each direction, the use by day by crossing flagmen of a white disk with the word "Stop" standing out prominently, instead of the varicolored flags now in use, and the use by night of a red lantern. They also call for the painting of crossing gates in one certain way, the removal as far as possible of obstructions to a clear view of coming trains and the grading of approaches so that free passage of vehicles will not be impeded.

These suggestions, highly commendable in the main, are not all new. Several railroads, recognizing the inadequacy of the old protective devices against fast-going automobiles, have been working along similar lines. If the recommendations of the commissioners are to be carried out the constituted authorities must take it upon themselves to provide the sites for the signs, to help grade the approaches and to induce adjacent property owners to remove unnecessary obstructions to vision. And all this will work toward that co-operation in the expense of grade-crossing protection that seems to this journal as desirable as co-operation in the expense of grade-crossing elimination.

But the public and the railroad should not relieve the autoist of all responsibility. We are said to be a nation of gamblers, and so long as it is a fair wager that there is no train coming, or that we can beat the train to the crossing if it is coming, many of us will continue to take the chance in spite of disks, bells and gates. Therefore on out-of-town highways, where speeding prevails, the approaches, instead of being graded to permit unimpeded passage across the tracks, should be graded to impede such passage, by steep bumpers or ridges across the roadway, as proposed by T. G. Dabney in the Engineering Record of Nov. 11, page 600. Failure to slow down at such a bumper would mean disaster, and only the veriest speed maniac would bet on a sure loser.

The Channel Tunnel

THE history of the project for a tunnel under the English Channel, outlined on page 645 of this issue, affords an example of traditional British conservatism. It has been up time and again, but for one reason or another—and generally on account of military considerations—has been allowed to lapse.

European geologists and engineering experts tell us that the actual construction of this project would be simple compared to the difficult problems entailed by enormous earth pressures, tilted and faulted strata and great flows of water met in driving the Simplon and other Alpine tunnels. Indeed it is probable that the first attempt at the construction of a tunnel under the channel, begun more than forty years ago, could have succeeded even with the limited means and experience then available. Not construction difficulties but the obstinacy of the British public halted the first effort to drive the tunnel.

The task of the promoters has thus been without parallel in the history of great enterprises. Instead of having to convince the nations concerned that the project was feasible, profitable in itself and of great economic advantage to both parties—points conceded from the outset—the promoters have been faced with the more serious difficulty of combating an unfounded prejudice. The idea that such a tunnel would destroy England's insular position and lay her open to easy invasion took such deep root in the British mind that this project of international importance has stood checkmated since 1882. It has taken a European catastrophe to uproot this prejudice and bring England to the point of seriously considering a great public work which would not only be of economic benefit but might be of inestimable military value. The threat of the submarine to England's sea power, and the object lesson of Germany, far better able to live within herself than Britain, yet seriously hampered in the present conflict by blockade, are believed to have won for the proposed tunnel a consideration which was denied to better arguments.

There is no doubt that this project, which, large as it is, would cost less than the sum spent in a few days by England alone to carry on the war, could be financed at the present time. Were the money not available in England, it is safe to say that American bankers would require no further demonstration of the practicability of the project, and would welcome the opportunity to furnish funds for a profitable commercial enterprise of this character, in view of the far greater sums they have already loaned for more destructive purposes.

It is to be hoped that this time British objectors will be convinced or silenced, and that the project will realize the success its merits should have won for it long ago.

Dr. Douglas' Gift and Its Significance

THE GIFT by Dr. James Douglas of $100,000 as the beginning of an endowment fund for the library of the United Engineering Society is an indication of the great accomplishments made possible by the union of headquarters of the national engineering bodies. The officials of the library hope that the endowment will reach $1,000,000, and they are already making plans for expansion which will make this library unique, not only in its collection of technical books and periodicals, but also in the service it will be prepared to render the members of the profession. The library, through its efforts in forming committees to classify engineering knowledge, its index of technical periodicals available in various libraries of the New York metropolitan district and its information service on current engineering literature, has demonstrated its virility and its determination to leave nothing undone which will make its resources more readily available to those seeking information on engineering subjects.

The plans for the future cannot all be made public at this, their formative, stage. Announcement has already been made, however, of the plan to place on the library shelves every engineering periodical published in the world, no matter in what language. Already the library receives regularly 1000 technical periodicals. There are some 250 more not on the mailing list at present. It is proposed that these shall be added, and that the library will then, through its information service, be able to tell anyone seeking a particular class of information when data on that subject have appeared.

It can be expected that if this ideal—of securing all that is available throughout the civilized world—controls the plan for the periodical division, a scope equally broad will control the policy of the library with reference to the acquisition of engineering books. Those familiar with library resources claim that the consolidation of the library of the American Society of Civil Engineers with that of the societies already on Thirty-ninth Street has made the united collection the greatest reservoir of technical information. With the plans in hand, the position of the library will be strengthened, while at the same time its resources will be made more readily available.

Moreover, the needs of the enlarged library have been constantly in the minds of those who are planning the addition to the building. The space available for the library will be greatly enlarged, while the facilities are being so planned as to conduce to the utmost serviceability of the library resources. Among the additions will be a number of small study rooms which can be allotted to individual investigators who expect to spend much time in the library.

Reverting to the larger possibilities suggested by Dr. Douglas' gift, one cannot help feeling that the predictions made by those who urged that the civil engineers vote favorably on the proposal to move to Thirty-ninth Street have been vindicated. An idea of broad compass is always more stimulating than a narrower one, and no matter what the standing of the great engineering societies as individual bodies, their appeal to the imaginations of engineers must be far less than that of a single united profession. It was this thought of a closer union between engineers of every persuasion that stimulated Dr. Douglas to make his gift. The same thought was controlling, too, in the mind of Ambrose Swasey when he endowed the Engineering Foundation, even though the consolidation of headquarters had not then been proposed. Mr. Swasey stipulated that the civil engineers should have a part in the management of the foundation.

The great idea—professional unity—which has stimulated Dr. Douglas and Mr. Swasey will undoubtedly stimulate other leaders of the profession who are well endowed with this world's goods. Undoubtedly, we are but at the beginning.

The engineering societies are amply able to keep up the present work for their memberships and to expand that work with the years. Large endowments, however, will enable the work to go along much faster and to realize plans which otherwise must be kept in abeyance for a long time.

Truly the determination of the civil engineers to move to the Engineering Societies Building was a momentous one.

Leadership Through Industrial Research

CONGRESS will shortly convene and among the subjects which will come up for discussion will be the appropriations for the Bureau of Standards. In normal times it is natural for engineers and industrial leaders to be interested in the bureau's appropriation. Now the interest should be redoubled. Both here and abroad a new light has broken as to the bearing of research on the national welfare. Germany and England in this respect form a striking contrast. The former owed her tremendous growth in foreign trade to her thorough and extensive scientific investigation. England, on the contrary, was blind to its benefits, and its commercial power, relative to Germany's, shrank. In other words, Germany's commercial progress has been predicated on discoveries made in the laboratories of her engineers and chemists.

We have occupied a middle ground. We have not developed the research perfection of Germany; neither have we neglected this agency as has England. Our electrical industry, notably, has been brought to its present great strength and its world leadership through research work, while other branches of manufacturing, though on a smaller scale, have been strengthening themselves by making sure of the scientific foundation on which they stand.

The colleges, too, in this respect, are farther ahead than those of England. Notable engineering researches have been carried on, particularly in the experiment stations of some of the institutions of the Middle West, while the scientific laboratories in a great number of schools have produced stimulating discoveries which, even if not directly, have nevertheless indirectly had a commercial bearing.

Furthermore, the government has not stood still. In structural, metallurgical and electrical lines, the Bureau of Standards has rendered signal service. It has made a marked impress upon industrial fields and has assumed an undisputed leadership in many lines of research work.

It must not be thought, however, that we can be satisfied with what has been accomplished. Striking evidence that there is still much to do is afforded by the recent organization of the National Research Council. Engineers, chemists and scientists generally have joined hands in order that the scientific brains of the country may be mobilized and every agency put to the work for which it is best adapted. And the keynote of the council's work is patriotic—the welfare of our whole country. Industrial preparedness is essential if the United States is to make progress in foreign markets. Unless our processes are continually improved, unless all the experience that this country produces is brought to bear on our industrial problems, we shall not be able to compete with European manufacturers backed by thoroughgoing scientific research.

Certainly in a matter so vital to the welfare of the nation, the government itself should not be backward. No matter how great its appropriations for the Bureau of Standards, the industries and the universities will nevertheless redouble their research study. President Butler of Columbia University, for example, has recommended an endowment of $6,000,000 for a great research laboratory.

There will always be broad problems, however, which particular industries and smaller laboratories either have no incentive to handle or are unable to take up because of limited means. These general, these broad problems are essentially the kind that the government should attack. Even within the realm of problems applicable to a limited field, government work is desirable in order that there may be some public check and light on the results that are obtained by private laboratories.

Though the bureau's budget for the year 1917-18, which will shortly be before Congress, are not known, it is safe to say that the requests denied last year will be repeated. Among these was an additional $50,000 for investigations of structural materials, $50,000 for the site of an engineering laboratory, to house the work now being done in War Department buildings at Pittsburgh; and authorizations for a suitable engineering laboratory building and an immense, and much needed, transverse testing machine to take full-size, built-up members. The laboratory building would cost $250,000 and the testing machine an equal sum, though only $25,000 was asked for the current year under each heading as an initial appropriation.

Appropriations for other lines of work, of equal importance in their respective fields, were asked for last year and denied. These, too, we presume, will be again requested.

Industrial research is so important to our national welfare, and the time so propitious—considering the awakening to the importance of research—that engineers and industrial leaders should not fail to impress upon their representatives in Congress the importance of large appropriations for the bureau. Exclusive of building appropriations, the amount allotted for the current year is about $750,000. An increase of this appropriation to a million or a million and a quarter is hardly an unreasonable request, considering the vital character of the work that the bureau should do.

$600,000 Washington Irrigation Project, Financed by Landowners, Completed in a Year

West Okanogan System First to Be Built Under Washington Law—Land Speculation Prevented—Transition from Circular to Rectangular Section Without Loss of Head

By J. C. STEVENS
Hydraulic Engineer, Portland, Oregon

THE WEST OKANOGAN valley irrigation project, probably the only one financed and built during the present war period, was surveyed, designed and constructed in less than one year. It will water 10,000 acres of land in the Okanogan River valley, Washington, extending for 30 miles south of the Canadian boundary line. The main-line construction involved 36 miles of earth ditch, 27 miles of wood and steel flume and 4.4 miles of wooden pipe—a total of 67.4 miles of conduit. The sum the district could afford to spend was determined. The best system for that money was then designed and built.

This project is the first of its kind built under the irrigation district law of the State of Washington. Under the provisions of that statute the landowners organized an irrigation district and voted $600,000 in 20-year 6 per cent bonds to cover the cost of construction. Through the efforts of that great empire builder, James J. Hill, the bonds were duly subscribed for and bids invited on the construction work.

SYSTEM COMPLETED IN A YEAR

A contract for the construction of the irrigation system was signed between A. Guthrie & Company of St. Paul and the board of directors of the West Okanogan Valley Irrigation District July 7, 1915. Just one year later—July 7, 1916—the completed project was formally accepted by unanimous vote of the directors, and the works were taken over by them for operation and maintenance. The contract price was $511,650.

The project lies in the most favored fruit section of Washington. It is doubtful if there exists a condition of soil and climate more favorable to growing apples and other orchard products. The lands, however, are not being devoted exclusively to the growing of fruit, but also to diversified farming. On the hills bordering the valley are extensive cattle ranges, and the raising of alfalfa and other forage crops will be combined with fruit culture.

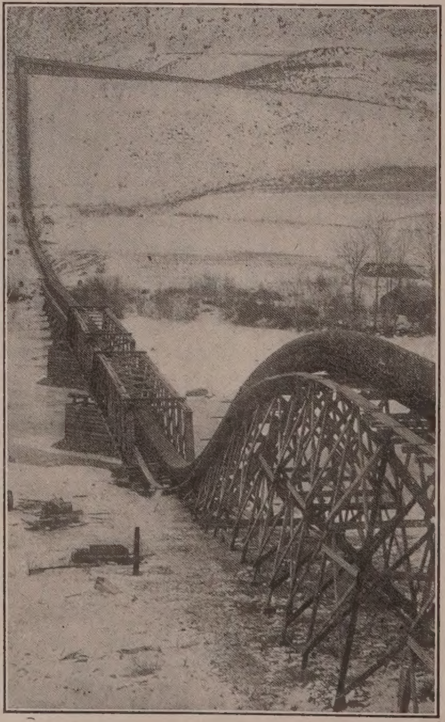
The water supply is taken from the Similkameen River, 11 miles above the town of Oroville. As the minimum summer flow of this river is three times the maximum diversion for irrigation, an abundant supply of water is assured. The main canal, consisting of 5 miles of earth ditch and 6 miles of wooden flume, has a capacity at the head of 150 sec.-ft. At Oroville the water is divided three ways. The main portion—104 sec.-ft.—crosses the Similkameen River in a 46-in. wood-stave pipe 2913 ft. long and continues southward on the west side of the Okanogan valley. Twenty-seven second-feet are carried across the Okanogan River just above Oroville in a 30-in. wood-stave pipe 7635 ft. long to the east side of the valley. There it divides north and south. The third portion—9 sec.-ft.—continues north on the west side to the Canadian boundary line. Ten miles below Oroville a wood-stave pipe 34 in. in diameter and 4588 ft. long carries 45 sec.-ft. from the west to the east side of the valley, where it divides north and south.

The map gives the layout and general features of the project. The general character of the Similkameen River cañon and surrounding country is shown in one of the pictures.

Work was practically suspended during the winter. No grading could be done on account of frost, and an unusual snow made work on the flumes very trying. Wooden pipe was, however, laid whenever possible throughout the winter season. The curve shows the progress during each month for the year.

CONDUITS TESTED BEFORE ACCEPTANCE

The contractor was obliged to test out all conduits to 60 per cent of their maximum carrying capacity before acceptance by the district. This rigorous requirement for new canals and flumes was met without serious mishap. Water was turned into the main canal at the head early in March, and gradually increased day by day until the 60 per cent was being carried as far as the first spillway. During that period a crew of men patroled the line. Stretches of earth ditch that showed excess seepage were puddled; leaks in flumes were stopped by throwing in a small amount of soil or, where necessary, by calking with oakum. As soon as the next stretch of canal was ready, water was let into it gradually until the required amount was being carried. In this manner all portions of the systems were primed as near to the required amount as was possible with the available spillway facilities.



THE SIMILKAMEEN SIPHON, WINDING OVER THE COUNTRY, MIGHT BE LIKENED TO A MAMMOTH SNAKE

The official tests and measurements were made July 1 and 2 by the board of directors of the district, the engineer in charge, the superintendent for the contractor and the irrigation manager. At this time it was found that all lines were carrying from 60 to 90 per cent of their respective capacities. During the tests there were no breaks, no settlement and no damage or signs of weakness in any of the lines or structures.

NO LEAKS AFTER PRIMING

Minor breaks in the earth ditches at critical points during the period of priming were repaired quickly. Flumes showed a tendency to settle, particularly on steep earth or clay slopes. In such cases the leakage that inevitably occurs between the time water is turned in and until the boards have had time to swell tight will often cause settlement. At such points the joints were generally calked with oakum in advance to minimize the danger as much as possible.

After the "priming" was completed the flumes and pipes became remarkably tight. For thousands of feet along some of the flumes not a drop of escaping water could be seen. It seems almost incredible that flumes made of so many pieces of rough lumber could be made to hold water so effectively.

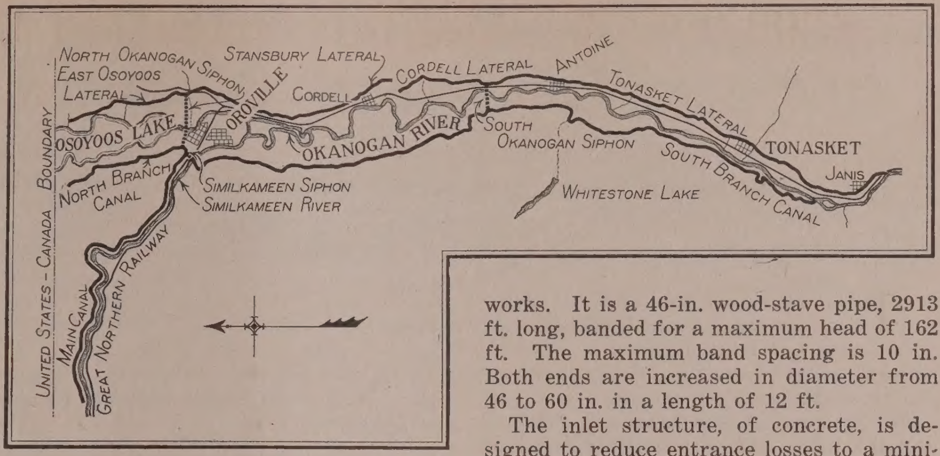
Portions of the earth canals were excavated in very gravelly and sandy soils. Excessive seepage occurred at some of these sections when water was first turned in—enough in some instances to cause sloughing of hillsides and seriously to menace cultivated lands below the canals. At these places patient work of puddling was always rewarded by a gradual reduction in losses, until all visible seepage was finally stopped.

LAND SPECULATION PREVENTED

All lands under the system are in private ownership except 1400 acres allotted to Indians. Holdings vary from 20 to 320 acres. Before contracts for construction were signed about one-third of the lands for sale in the district were listed under contract to sell for stipulated prices. This was done to forestall land speculation and to insure land being sold at reasonable prices to those who would actually reside on and cultivate it. About 4000 acres are now under irrigation. Sales have been moderate, but there has been little or no land speculation—a condition indicative of steady, healthy growth which promises ultimate success.

During the last session of Congress sufficient money was appropriated to enable the U. S. Indian Service to purchase water rights for all Indian allotments under the system. When the negotiations are completed bonds to an amount corresponding to the value of these water rights will be retired.

If a strictly permanent type of construction had been a prerequisite of the West Okanogan irrigation project the system could not have been constructed. It was therefore necessary to build the best possible system with the funds available. Wooden flumes having an estimated life of 10 years were adopted and provision was made for a replacement fund to rebuild them during the life of the bonds. On steep hillsides, where the line went through treacherous clay, and where even slight leakage would be destructive, steel flumes were used. The life of the wooden pipe was estimated at twenty years—the same as that of the bonds. Where inlets or outlets of important pipe lines were in earth ditch, concrete structures were built and special preservative measures adopted for the pipes themselves.



GENERAL MAP OF WEST OKANOGAN IRRIGATION SYSTEM

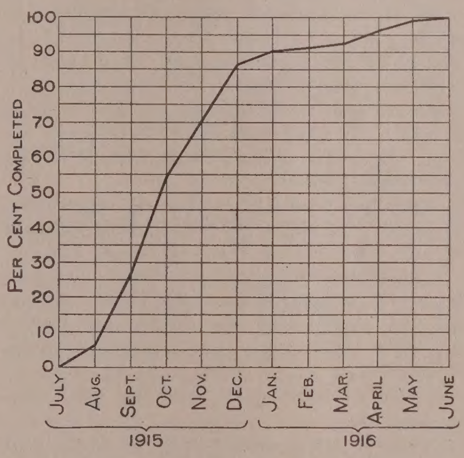
Intake of Main Canal

The intake of the main canal is of concrete, with steel gates, and is so arranged that accumulation of débris is prevented. In all structures the hydraulic functions were designed to minimize losses of head and to insure their operation with the least possible outlay for maintenance. That this has been done is evidenced by the fact that the first season's operation has been accomplished with practically no interruption in the flow of water to the irrigators. The single exception is a few days in July, when a minor break in the main canal was caused by an unprecedented cloudburst. No unusual expenses have been incurred and all lands have had an abundant supply of water.

The headworks, the plan of which is shown, diverts the water without raising the level of that in the river or obstructing its flow. The river at that point is about 300 ft. wide with an average depth, at low water, of 2½ ft. The gates are formed of 18-in. channels to close the 14-in. openings under the curtain walls. They have skeleton extensions of light angles to prevent binding in the guides. The gate sills are at the level of the river bed at the shore, and at low water the maximum required for the canal is secured even if the depth of flow over the sills is not more than 0.7 ft.

The gate structure is placed practically in line with the shore. The ends of the piers are faced with H-bars to form guides for flashboards. Steel rails were bolted on the front face of these H-bars, parallel with the river, to deflect driftwood. Except at extreme low water, it is expected that one or two 8-in. flashboards will be left on the bottom of the guides to prevent gravel from being carried over the gate sills and into the canal.

A sluiceway on the downstream end of the gate structure can be closed by flashboards to raise the level a few inches at extreme low water if necessary. When the sluiceway is open, it, with the diversion dike, produces a scouring action in front of the gates which prevents accumulation of sand and gravel.



CURVE SHOWS PROGRESS OF WORK

The diversion dike is very low and extends diagonally upstream about one-third the width of the river. As it is made of loose boulders, water flows over and through it at all stages of the river. The dike deflects the flow toward the gates.

Similkameen Siphon

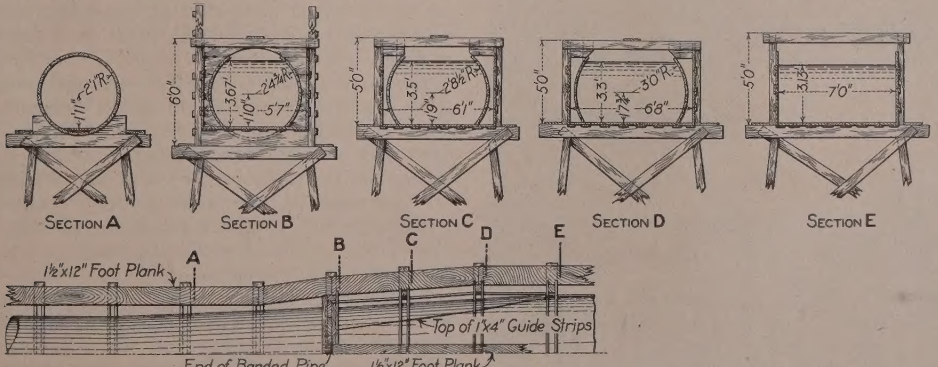
The Similkameen siphon carries a maximum of 104 sec.-ft. across Similkameen River at a point 11 miles below the headworks. It is a 46-in. wood-stave pipe, 2913 ft. long, banded for a maximum head of 162 ft. The maximum band spacing is 10 in. Both ends are increased in diameter from 46 to 60 in. in a length of 12 ft.

The inlet structure, of concrete, is designed to reduce entrance losses to a minimum. The pipe diverts practically at right angles to the main canal on a steep hillside. A curved diversion wing extending upstream into the main canal is intended to divide the water in two portions, 104 sec.-ft. going into the pipe and 36 sec.-ft. continuing in the north-branch ditch. Complete control of either line is secured by one set of flashboards in the concrete structure. For less than maximum flows, flashboards are inserted until the desired depth is secured in the north branch, the water to the pipe spilling over the top of the flashboards. This method of control was not costly. It also has been found to be very elastic.

Section Changes from Round to Square

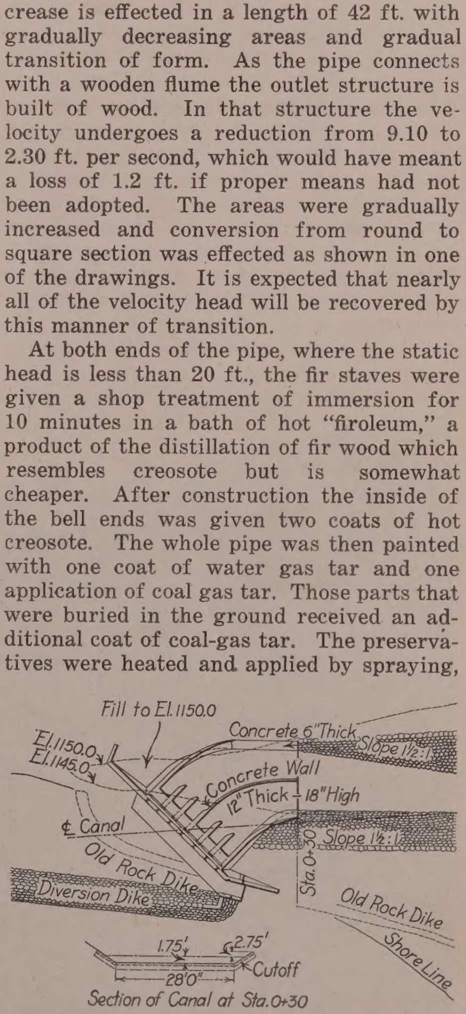
In passing from the main canal to the pipe the velocity of the water is increased from 2.24 to 9.10 ft. per second. This increase is effected in a length of 42 ft. with gradually decreasing areas and gradual transition of form. As the pipe connects with a wooden flume the outlet structure is built of wood. In that structure the velocity undergoes a reduction from 9.10 to 2.30 ft. per second, which would have meant a loss of 1.2 ft. if proper means had not been adopted. The areas were gradually increased and conversion from round to square section was effected as shown in one of the drawings. It is expected that nearly all of the velocity head will be recovered by this manner of transition.

At both ends of the pipe, where the static head is less than 20 ft., the fir staves were given a shop treatment of immersion for 10 minutes in a bath of hot "firoleum," a product of the distillation of fir wood which resembles creosote but is somewhat cheaper. After construction the inside of the bell ends was given two coats of hot creosote. The whole pipe was then painted with one coat of water gas tar and one application of coal gas tar. Those parts that were buried in the ground received an additional coat of coal-gas tar. The preservatives were heated and applied by spraying,

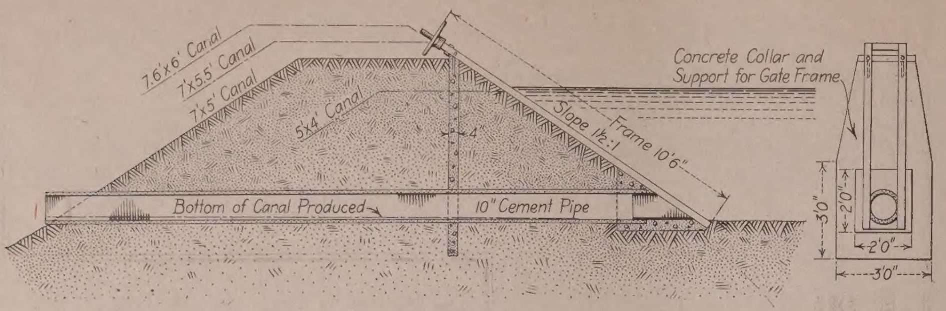


STEPS IN TRANSITION FROM CIRCULAR TO RECTANGULAR SECTION

Between sections B and E standard flume construction was used, with 1 x 4-in. guide strips nailed to radial collars at bents



GENERAL PLAN OF HEADWORKS OF MAIN CANAL



LATERAL HEADGATES FOR DIFFERENT SIZE CANALS

using compressed air from a portable gas-engine outfit.

The pipe was laid above ground wherever possible, but in crossing cultivated lands it was sometimes necessary to bury it. A wooden bridge composed of two 120-ft. Howe truss spans, with pile-bent approaches, carries the line over the Similkameen River.

NORTH OKANOGAN SIPHON

The North Okanogan siphon crosses the Okanogan River just above Oroville and carries 27 sec.-ft. to the east side of the valley. The pipe is 30 in. in diameter. To the Y, where it branches north and south to supply laterals, is 7635 ft. The north branch is made up of 438 ft. of 18-in. and 376 ft. of 20-in. machine-banded pipe. The south branch is an 18-in. pipe 552 ft. long. The intake to the 30-in. pipe and the outlets of both branches are of concrete. The same plan of applying preservatives and paints was used on this as on the Similkameen siphon.

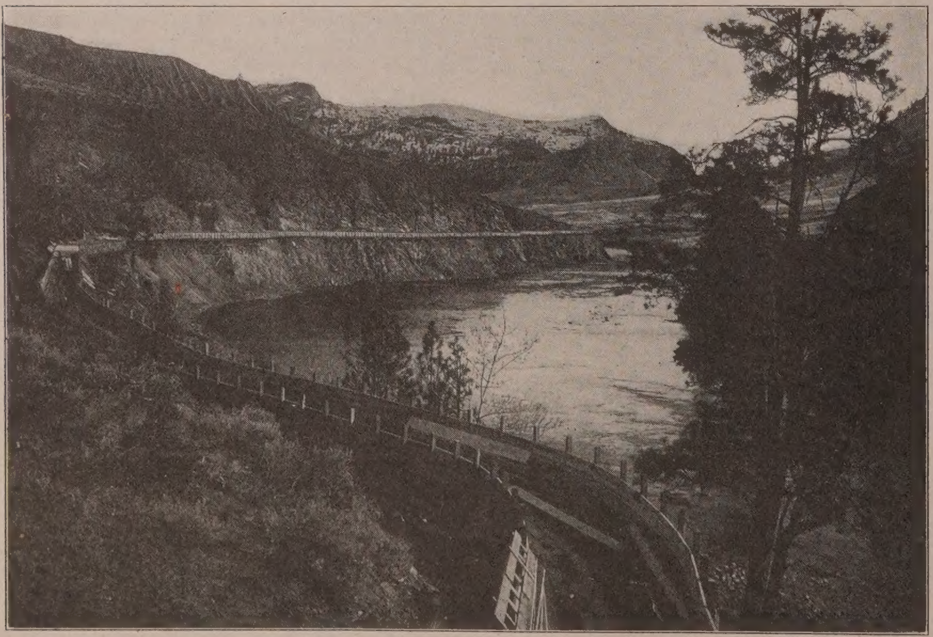
From each branch there is a compound pipe of 10 and 12-in. sizes with a gate valve, leading to a common concrete surge box. Each of these waste pipes is so designed that when the valve is open for maximum flow the friction and velocity heads in it are equal to the static and friction heads in the main pipe beyond the point where the waste pipe joins. In the extreme end of each branch pipe a simple butterfly gate was installed. This was made of 1¼-in. lumber mounted on a 1-in. iron shaft, and so designed that the gate may be held in any position. By manipulation of this butterfly gate with the gate valves in the waste pipes complete regulation is secured.

SOUTH OKANOGAN SIPHON

This pipe line crosses the Okanogan River at a point 10 miles below Oroville. It carries 45.6 sec.-ft. from the west to the east side of the valley. There 36.2 sec.-ft. flows southward into the Tonasket lateral and 9.4 sec.-ft. flows north into the Cordell lateral. The pipe is 34 in. in diameter and 4588 ft. long. Both ends are belled to a 40-in. diameter in a length of 12 ft. The inlet structure is of wood and designed to reduce entrance losses to a minimum. At the outlet no special attempt was made to recover velocity head. The pipe ends in a concrete well which discharges into a large wooden box with weirs and flashboards for controlling the division of the water to the two branches.

The Tonasket siphon carries 16 sec.-ft. through Tonasket and across Bonaparte Creek. It is 3718 ft. long, made of continuous wood staves and is 26 in. in diameter. Through the town the pipe is buried in the streets and alleys. On account of the low heads the buried portions were given three coats of coal-gas tar instead of two as was the case with the other pipes.

The Siwash siphon, 593 ft. of 26-in. continuous wood-stave pipe; the Whitestone siphon, 641 ft. of 28-in. pipe; the Ninemile and Cache Creek siphons, of 488 and 498 ft. respectively of 18-in. machine banded pipe, and the Peterson Creek siphon, 275 ft. of 16-in. machine-banded pipe, were built in addition to those before mentioned.



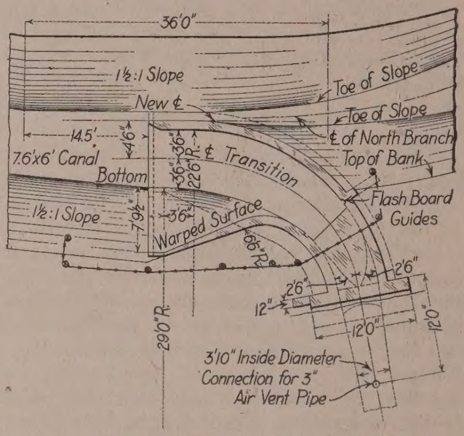
MAIN LINE FLUME ON HILLSIDE UNDER CONSTRUCTION

PRESERVATIVE TREATMENT

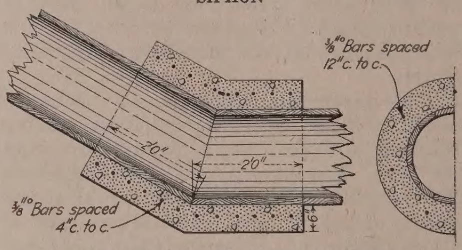
The staves of all continuous stave pipe for all static heads of less than 20 ft. were given a 10-minute bath in hot firoleum. After construction all pipe was painted with one coat of water-gas tar, and one coat where exposed, or two or more coats of coal-gas tar where buried.

The machine-banded pipe for all heads less than 20 ft. was given the hot firoleum bath after winding. All pipe was dipped in hot tar and asphaltum before shipment.

The joints of all machine-banded pipe were of the insert type. No sleeve joints were used. The insert is not so elastic as the sleeve joint, since with the former a deflection of ½ in. at each joint is about the limit. Sharp curves were made by the use of reinforced-concrete elbows, as shown. The portion of the pipe embedded in the concrete was thoroughly cleaned of all tar by first scraping and then scrubbing with caustic soda. The results were very satisfactory and no leaks have been detected in any of them.



PLAN OF UPPER TRANSITION SIMILKAMEEN SIPHON



CONCRETE ELBOW FOR WOOD PIPE

DISTRIBUTION SYSTEM

The distributing laterals were designed to deliver water for irrigation under the rotation plan. As the lands are somewhat rolling, a minimum of 2 sec.-ft. was allowed in all distributing ditches, flumes and pipe lines.

All laterals and deliveries were designed with trapezoidal weirs in earth sections and suppressed weirs in flumes. The system was constructed to carry water to each 40-acre tract or fractional lot. Water is delivered to the high point in each tract or, where impracticable, to the margin of the tract, at sufficient elevation to reach the high point.

Headings from the larger canals are of steel and concrete. The steel headgates were especially constructed for a 34-deg. slope by the Columbia Engineering Works of Portland. The top is supported on an extension of the cutoff wall, which makes a simple and effective installation.

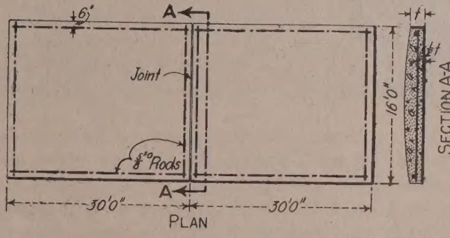
The cement pipe used on the distribution system was made on the shore of Lake Osooyos and hauled to place. Plain pipe with male and female joints was used. In laying the pipe in the trench the male end was touched up with mortar before joining, and a wrap of mortar was made by rolling in a piece of cheesecloth long enough to reach around the pipe. By wrapping this roll of mortar around the outside of the joint and patting it with the hand a practically watertight joint was secured.

The affairs of the district are administered by a board of three directors elected from among the landowners. H. K. Bowen of Tonasket is president. Erwin Truax and George I. Cole of Oroville constitute the board of directors; E. Riste of Oroville is secretary, and J. Criswell, irrigation manager.

During construction, D. C. Henny of Portland was consulting engineer, R. F. Hoffmark was superintendent for A. Guthrie & Company, the contractors, and the writer was engineer in charge. All wood pipe was furnished by the Portland Wood Pipe Company of Portland.

Simple Reinforcement Suggested to Stop Concrete-Road Cracks

A CAREFUL study recently made by engineers of the U. S. Office of Public Roads and Rural Engineering of the cracks which have developed in the Ohio Post Road, which is 24 miles in length and surfaced with plain Portland cement concrete, indicates that the cracks are gradually becoming wider, not only because of the spalling of the edges, but also because of separation between the different parts of the cracked slabs. The separation is generally more noticeable near the joints or at the outside edges of the slabs, depending on whether the cracks are longitudinal or transverse, and it has also been observed that fresh cracks usually begin at the edges of the slabs or at the joints.



HOW SINGLE-ROD REINFORCEMENT SHOULD BE PLACED IN CONCRETE SLAB

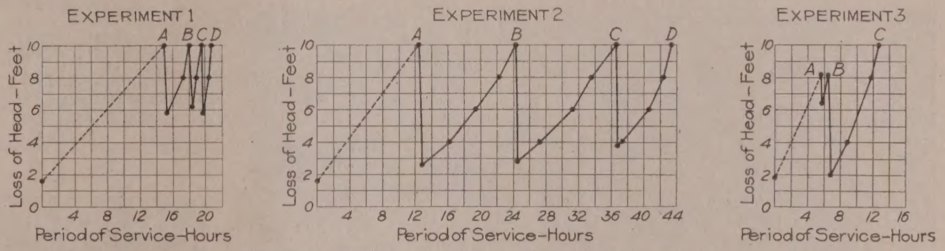
These facts have suggested to Messrs. Moorefield and Voshell, senior highway engineers, that the formation and widening of cracks may be prevented in great measure by employing a simple method of reinforcing. The method of reinforcing which they propose would consist in placing a single rod in the concrete about 6 in. from each of the four edges of the slabs, as shown by the sketch. It is estimated that for a 16-ft. pavement with joints spaced 30 ft. apart, ⅝-in. round rods, spaced as indicated, would probably provide a reasonable safeguard against the formation and widening of cracks.

If this method of reinforcing should prove efficient, the amount of steel required would be very much less than is necessary with any other method which has so far been tried.

Periods of Filter Service Increased 250 Per Cent

Modified Methods of Operation Effect Marked Economies at Cincinnati Water-Purification Plant, According to J. W. Ellms and S. J. Hauser

INCREASES as high as 250 per cent in the periods of service of the mechanical filters of the Cincinnati water-purification plant have been realized by a modified method of operation, involving merely the closing of the effluent valve and the admission of a small amount of wash water—without wasting any water to the sewer. These measures proved particularly effective when the normal periods of service of the filter units were shortened by quantities of micro-organisms which clogged the sand beds, resulting in a high loss of head and the introduction of entrained air into the filtering medium. How these striking economies in filter operation were accomplished was explained at the annual convention of the American Chemical Society (sanitary engineering section) in a paper by Joseph W. Ellms, superintendent of filtration, and Stephen J. Hauser, chemist, of the Cincinnati Waterworks. The paper, in condensed form, is given below.



RESULTS OF THREE EXPERIMENTS BASED ON MANIPULATION OF VALVES

1—Effect of closing effluent valve for 10 minutes, thereby liberating entrained air. 2—Service period lengthened by closing effluent valve and opening wash-water valve during high loss of head. 3—Effect of closing effluent valve and opening wash-water valve during low loss of head.

MICRO-ORGANISMS CLOG FILTERS

With rapid sand filters the usual method of relieving clogging due to micro-organisms is to wash the filter. This may mean under the worst conditions an increase in the amount of wash water from 8 to 10 times the quantity normally used. A reduction in the output of a plant from 10 to 15 per cent, on account of the added volume of wash water needed and the increased power and labor required to keep the plant in operation, imposes a burden on the plant that few operators fully realize unless they have passed through the experience.

The troubles produced by micro-organisms in the operation of the rapid sand filter plant at Cincinnati have been entirely those caused by shortened periods of service.

The character of the organic matter during the summer and fall months is such that it forms a rather heavy colloidal coating on the sand grains that is particularly effective as a filtering medium. In consequence it becomes possible to operate filters to a comparatively high loss of head and still produce an effluent of high quality. From 10 to 11 ft. loss of head can usually be obtained, while a rate of filtration equivalent to about 125,000,000 gal. per acre per day is maintained. The period of service at this rate may range from 3 to 70 hours.

When filters are operated to a high loss of head air is usually liberated from the water and becomes entrained in the sand bed. The escape of some of this air takes place, of course, when the effluent valve of the filter is closed, and filtration ceases. More air escapes upon the application of wash water. It was noted in the operation of the Cincinnati filters that by merely closing the effluent valve, with the consequent escape of some entrained air, and then reopening this valve, the loss of head decreased, and a further period of service could be obtained. Accordingly, systematic experiments were commenced during a period of shortened filter runs to determine what influence disturbance of the sand surface by various methods had on the period of service of the filter and on the quality of the filtered water.

Diagram 1 shows the effect of closing the effluent valve for 10 minutes at a loss

ACTUAL RESULTS OF USUAL AND MODIFIED METHODS OF OPERATION OF THE CINCINNATI FILTERS WHEN APPLIED WATER WAS INFESTED WITH MICRO-ORGANISMS

Date	Period of service, hours Normal	Including extended periods	Bacteria per c. c. filtered water Effluent from filters	Outlet filtered-water reservoir	Total water filtered, gal.	Wash water used, gal.	Wash water saved, gal.
Aug. 27	23.21	....	7	16	48,403,000	744,000	....
Aug. 28	22.66	....	11	27	62,653,000	1,023,000	....
Aug. 29	18.52	....	14	37	60,513,000	1,176,000	....
Aug. 30	12.16	....	12	38	55,987,000	1,658,000	....
Aug. 31	9.61	....	12	26	63,042,000	2,364,000	....
Sept. 1	7.33	....	12	34	59,612,000	2,928,000	....
Sept. 2	5.81	....	9	36	60,875,000	3,768,000	....
Sept. 3	*4.42	17.69	6	32	49,000,000	996,000	2,994,000
Sept. 4	*3.31	13.25	10	33	54,653,000	1,482,000	4,464,000
Sept. 5	*2.80	11.19	9	44	59,805,000	1,924,000	5,762,000
Sept. 6†	*2.25	8.98	9	‡23	70,083,000	2,808,000	8,406,000
Sept. 7	*2.59	10.36	160	‡12	52,292,000	1,812,000	5,454,000
Sept. 8	*2.50	10.00	470	‡20	69,583,000	2,505,000	7,515,000
Sept. 9	*2.93	11.72	460	‡13	59,945,000	1,842,000	5,520,000
Sept. 10	*3.42	13.67	430	‡10	47,138,000	1,242,000	3,720,000
Sept. 11	*3.94	15.76	260	‡6	59,472,000	1,362,000	4,074,000
Sept. 12	*3.60	14.38	130	‡12	67,458,000	1,688,000	5,056,000
Sept. 13	*3.74	14.97	85	‡23	59,972,000	1,440,000	4,332,000
Sept. 14	*4.12	16.49	85	‡9	60,055,000	1,308,000	3,940,000
Sept. 15	*4.04	16.17	80	‡32	59,722,000	1,326,000	3,996,000
Sept. 16	*4.23	16.93	55	60	52,222,000	1,104,000	3,540,000

*Estimated hours of service for the first period.
†0.48 p.p.m. of copper sulphate applied to the settled water and 1.2 p.p.m. to the applied water.
‡0.15 p.p.m. of chlorine applied to the filtered water from Sept. 6 to Sept. 15.
Average volume of wash water used per wash, 60,000 gal.

of head of 10 ft. or over, and the consequent escape of some of the entrained air. On an average it will be seen that at each closing of the effluent valve an increase of about 10 per cent of the normal period of service was produced. In other words, without any washing or agitation of the filter bed, other than that produced by the escape of entrained air, the filter run was lengthened about 30 per cent. The bacterial efficiency of the filter was not affected.

DIAGRAM 2

Diagram 2 shows the result of opening the wash-water valve for 1 minute (rate of application being 5000 gal. per minute) and of forcing filtered water up through the sand bed after the effluent valve had been closed. Two effects are here combined—the disturbance of the sand bed produced by the escape of all of the entrained air and by the movement of a small quantity of filtered water up through the sand bed. This method, entailing no loss of water, increased the period of service over 250 per cent, as compared with 30 per cent by merely closing the effluent valve as shown in diagram 1. The bacterial count is not affected by this method of agitating the bed.

In order to eliminate the effect on the sand bed of the escape of entrained air an experiment was made in which the effluent valve was closed when the loss of head was sufficiently low to prevent the liberation of air from the water. The results given in diagram 3 illustrate the effect of closing the effluent valve without liberation of air, followed by the effect of water agitation. The water was applied in the same way as in the previous experiments. The mere closing of the effluent valve has some slight effect in reducing the loss of head. The marked effect, however, is that produced by the opening of the wash-water valve, and shows that there can be effected an increase of practically 100 per cent in the length of the period of service for the same loss of head.

PRACTICAL BENEFITS

In order to show the practical benefit to be derived from this modified method of operating filters infested with micro-organisms the combined data of the operation results of the Cincinnati filters between Aug. 27, 1916, and Sept. 16, 1916, both inclusive, are given in the table. From Aug. 27 to Sept. 3 a progressive reduction in the period of service of the filters may be seen. On the latter date the modified method of operating was commenced. This method consisted of closing the effluent valve when the loss of head reached about 10 ft. and opening the wash-water valve so that filtered water passed upward through the sand bed for about 1 minute and at a rate of about 5000 gal. per minute. No water was wasted to the sewer. Ten minutes after the effluent valve was closed it was reopened, the opening of the wash-water valve having taken place during this period. The loss of head usually fell back to less than 2 ft., and the period of service was increased thereby nearly 100 per cent. This operation was repeated twice thereafter, or three times in all.

Up to Sept. 6 it will be seen that the bacteria in the filtered water remained low and that the number was fairly uniform. In order to learn the effect on the filters of applying copper sulphate to the settled and applied water 0.48 p.p.m. was introduced into the settled water and 1.2 p.p.m. into the applied water on Sept. 6. The amounts used were known to be insufficient to effect complete removal of the diatoms; and since the Ohio River was the source of the supply of organisms only temporary reduction in the number in the settled water could be hoped for. Some reduction was produced.

The anticipated result following the application of copper sulphate to the settled and applied water, namely, a tremendous increase in the bacterial content of the water, took place on Sept. 7. To counteract this increased bacterial load on the filters, chlorine was applied to the filtered water, beginning Sept. 6, and was discontinued on Sept. 15. The bacterial content of the chlorinated filtered water was uniformly low.

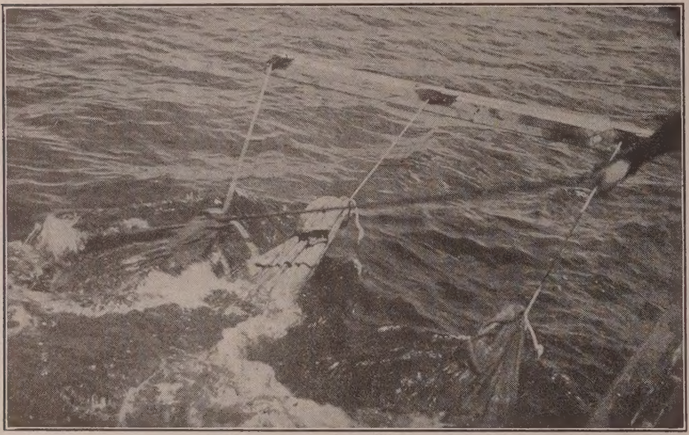
WASH WATER SAVED

Referring again to the table, the practical value of the modified method of operating filters is clearly proved by the great saving effected in the wash water used. During the period between Sept. 3 and Sept. 16 the volume of wash water estimated to have been saved amounted to 68,773,000 gal. The actual percentage of wash water used was 2.78. The percentage of wash water that would have been required if this modified method of operation had not been used is 11.16.

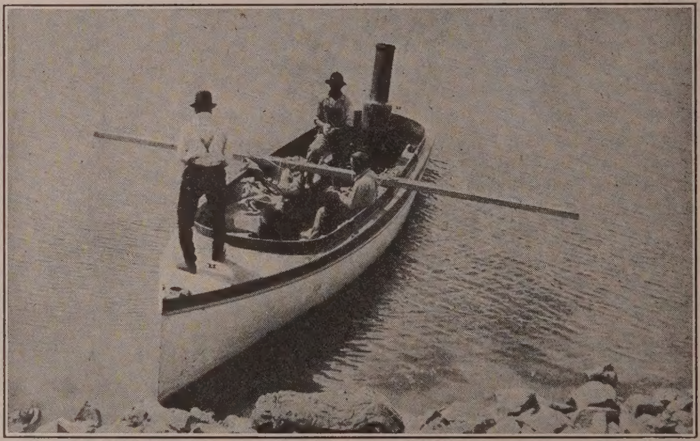
Outriggers and Pulleys Facilitate Copper-Sulphate Treatment

MOST of the hot weather in Denver passed before it was necessary to treat the water supply at Marston Lake with copper sulphate for algæ. The rise of anabæna to 500 standard units occurred late in August at the same time as synedra increased to 1500. One part of copper sulphate in 8,000,000 exterminated the offenders. Anabæna died at once, but the synedra required about a week, and after two weeks started to grow again, though not in sufficient numbers to cause trouble. Stephanodiscus started to multiply Oct. 1, reaching 4000 standard units, and then decreased rapidly, giving no trouble. Just previous to that time cheesecloth was placed on the revolving screens at the north outlet (see Engineering Record of Sept. 4, 1915, page 291). It caught all the crustaceans and nearly all the other organisms.

A new way of securing the bags to the outrigger on the launch, although merely a detail, eliminated past difficulties and expedited the work. Small sash pulleys for ⅜-in. sash cord were placed on the 3 x 6-in. by 20 ft. outrigger in recesses 2½ ft. apart, beveled so that the rope did not bind or rub. Six sacks with 50 lb. of the chemical were put out at a time. The salt dissolves in 20 to 30 minutes, so that changes have to be made often. The ends of the rope are secured to metal cleats on the outrigger just inside the boat. When a bag needs filling, one man with an iron hook pulls it into the boat, loosening the rope at the same time. With this outfit 4500 lb. was distributed over this 6,000,000,000-gal. 600-acre lake under the general direction of D. G. Thomas, chief engineer of the Denver Union Water Company.



HOOKING IN AN EMPTY BAG, AT SAME TIME LOOSENING UP THE ROPE



BOAT WITH OUTRIGGER CARRIES 1500 POUNDS OF COPPER SULPHATE

Highway Department Gives Equipment Depreciations

Upon completion of road-construction projects in Arizona depreciation per year on equipment used by the State Highway Department, according to the latest report, is as follows: Engines, gas and steam, 20 per cent; fresnos, 100 per cent; graders, 20 per cent; mixers, concrete, 20 per cent; mules, 10 per cent; pile drivers, 20 per cent; plows, 20 per cent; rock crushers, 20 per cent; steam shovels, 10 per cent; tents, 75 per cent; wagons and harness, 20 per cent; wheelbarrows and concrete carts, 50 per cent; trucks on daily rate on basis of life of three years, and all small equipment, such as picks, axes, shovels, etc., on the value at time of transfer to new project.

Driving of Tunnel Beneath English Channel Awaits British Parliament's Consent

French and English Companies, in Existence More Than Forty Years, Ready to Resume Work on Twin-Tube Rock Tunnel Discontinued in 1882

BRITISH DISTRUST of any physical connection with the continent, the obstacle that has barred since 1882 the construction of a double-track railway tunnel linking London with Paris under the English Channel, seems to have been overcome by the object lessons of the war. So far from rendering the British Isles more difficult to defend, French engineers have pointed out that such a connection might be England's only salvation were her control of the seas lost and her coast effectively blockaded. The construction of such a tunnel, suggested at the beginning of the nineteenth century and brought to the very point of actual accomplishment after the close of the Franco-Prussian War, would probably, because of favoring geological conditions, be attended with less difficulty and danger than the work of completing the far shorter Astoria gas tunnel under the East River in New York City. The proposed tubes would be excavated wholly in a thick bed of argillaceous chalk, highly impervious, soft enough to be readily excavated with tunneling machines and strong enough to stand up safely under a pressure of 210 to 280 lb. per square inch. The lowest points in the tunnel, near mid-channel, would be tapped by drainage galleries, which would be used, with the help of cross-drifts, to start work on the main tubes simultaneously at a number of points. Preliminary tunnels have been driven more than a mile beyond the shore line on either side in this stratum. They are still pumped out and carefully maintained, and experience with them is held to have demonstrated the practicability of the plan. Electric traction would be used to operate the 37 miles of double-track line, and both British and French estimates indicate that commercially the venture should prove exceedingly profitable. The entire project, including the present plans, which Mr. Asquith, the British Premier, has stated would be taken up by the Cabinet at an early date, is reviewed by A. Dumas, in *Le Génie Civil* of Oct. 21 last, from which article the facts here presented have been taken.

SCHEME LONG DELAYED BY BRITISH OPPOSITION

The scheme for establishing a physical connection between England and France across the Straits of Dover is an old one, a French engineer having suggested it to Napoleon as early as 1802. Serious proposals for a feasible project, however, began with the French engineer, Thomé de Gamond. Passing over Gamond's early proposals, which date back to 1834 and include a sheet-iron tube sunk on the bottom, an $80,000,000 bridge, two 5-mile riprap jetties between the ends of which a ferryboat would operate, a riprap causeway with three drawbridges, and his first tunnel scheme proposed in 1856, the first plan which formed the basis of definite action was proposed by him in 1866. This plan resembles the present one, except that it included a construction shaft and permanent station on an island to be made at the site of the Varne shoal in mid-channel. An Anglo-French committee of six was constituted in 1869 to carry out this plan, and although most of its original members are dead the committee is still in existence with full authority. After the war of 1870 the plans were modified by omitting the island station, which was considered too vulnerable to an enemy fleet.

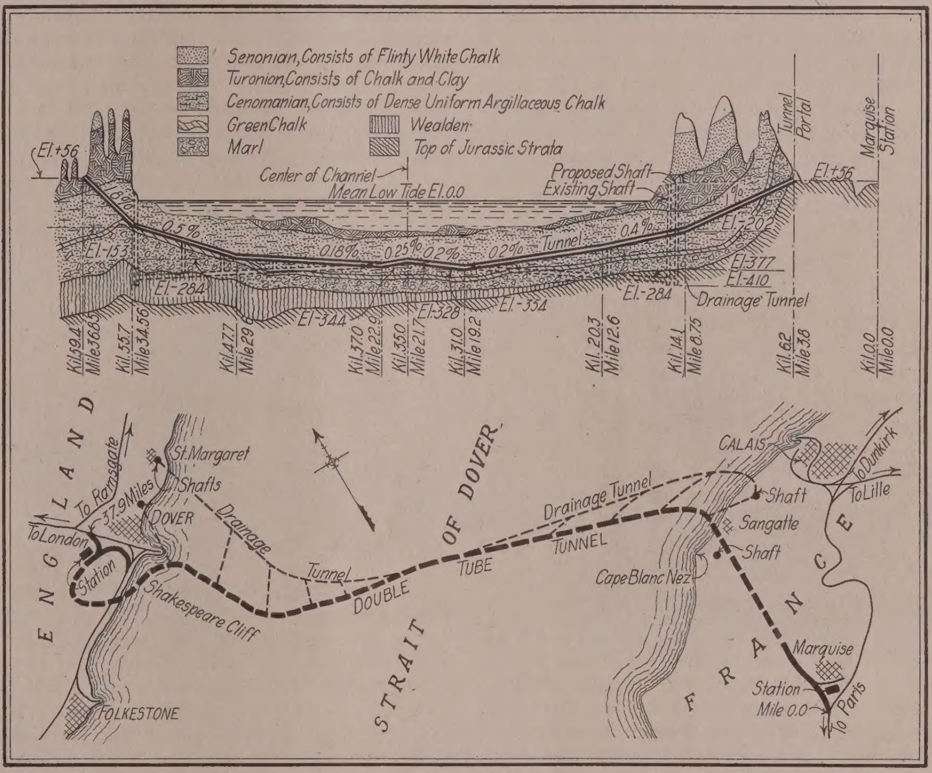
Boring machines tried out at that time were expected to complete this tunnel in four or five years at a cost of $40,000,000, and the net annual revenue from freight and passenger traffic was expected to reach $10,000. It was the intention to operate trains with compressed-air locomotives, and Gamond had worked out a scheme for compressing the air required by using the rise and fall of the tides. A French company was created by an act of Aug. 2, 1875, with a ninety-nine-year franchise to construct the French half of the tunnel and co-operate with a similar British company in carrying out the plans to be finally adopted by the commission above referred to. This company raised and spent more than $400,000 on shafts, soundings and borings. It constructed a trial tunnel 7 ft. in diameter, 6033 ft. long from the French shore. Its construction plant and underground workings have been maintained in good condition and the company is ready to go ahead with the completion of the project.

The British meanwhile had organized in 1872 the Channel Tunnel Company, which was merged by an act of July 16, 1874, into the Southeastern Railway Company. This company co-operated with the French company and spent $200,000 on exploration. It was succeeded within a short time by the Submarine Railway Company, which excavated two headings from the English shore, one 2641 ft. and the other 6075 ft. long. The shafts from which these tunnels were driven were sunk in the Shakespeare Cliff near Dover. This company was later merged into the Channel Tunnel Company, Ltd., which has maintained the early construction work and plant. Its tunnels have been pumped for a long period, and have shown a remarkably small quantity of seepage.

In 1875 Gamond died, believing that his project was to be put into immediate execution. However, popular outcry, led by London newspapers, definitely put a stop to continuation of the work in 1882. The conservative party succeeded in defeating motions made to resume construction in 1883, 1887 and 1906. It is interesting to note that at the last-mentioned date the French proposed, as a concession to England, to build a long section of the tunnel approach as an elevated railroad along the French coast, so that the British fleet could readily destroy it on occasion. As Dumas points out, this plan at present would scarcely appeal to the British mind. Were such a line in operation to-day, raids by enemy destroyers, submarines or sea planes would perhaps be able to keep it out of commission a good part of the time.

In spite of the opposition across the channel the project has never been lost sight of in France, and the plans have been revised and kept up to date until the present project, in many of its essential details, is practically a new one. Albert Sartiaux, chief engineer of the Compagnie du Chemin de Fer du Nord, and for some time a director of the French construction company, the Société Française du Chemin de Fer Sous-Marin, has been in charge of the engineering work and is responsible for the present plans.

Geological surveys of the channel, confirmed by the explorations already made,



PLAN AND PROFILE LOCATED TO KEEP LINE WITHIN SINGLE THICK IMPERVIOUS STRATUM

Cenomanian stratum dips to northeast, so that drainage tunnels also come within it, though apparently below it on profile.

indicate that the proposed tunnel will meet nothing resembling the tilted and faulted strata which caused such great difficulty in the construction of the Simplon tunnel and which resulted in the temporary loss of an entire heading while the Astoria gas tunnel under the East River in New York City was being built. The theory commonly accepted among geologists is that an isthmus connected France and England during the Miocene period and that subsequent settlement has caused the formation of a shallow strait. The indications are that this settlement was very gradual, and was not attended by any faulting or folding. The strata found on both sides of the channel correspond very closely in thickness, position and material. At the top is the well-known white chalk in which flint occurs, underlain by a stratum of chalk and clay. Beneath this in turn is a bed 200 ft. thick of compact argillaceous chalk which is very uniform and dense. It is extensively quarried for the manufacture of cement, and corresponds to the gray chalk found at Rouen in France. This material, while it does not require timbering, is rather easy to excavate and is nearly watertight. Soundings indicate that it maintains a uniform thickness for the entire distance under the channel, and lies approximately between the elevations indicated on the profile. The latest plans contemplate a thorough exploration of this bed from the drainage drifts, which will be constructed first, and a vertical alignment of the tunnel which will not require leaving this stratum except at the ends. The outcrop of this bed on both shores has determined the location of the line and of the junction stations shown on the plan.

TWIN TUNNELS TO BE BUILT

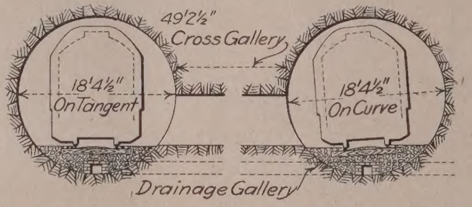
The present plans call for the construction of twin single-track tunnels 18 ft. 4½ in. in diameter and 67 ft. 7 in. center to center. The total length of the line from the junction with the Paris-Calais road to that with the railroad from London to Dover will be a little more than 37 miles of double track, about 32 miles of which will be in tunnel. The location on the French side, which is more definitely settled than that on the British, contemplates a maximum grade of 1 per cent, while a grade of 1.8 per cent is shown on the present plans at the British end. A short hump about 4 miles in length is planned at the middle of the channel, from each end of which water will be taken through drainage tunnels to pumping stations at shafts sunk on shore on either side. The two drainage tunnels will be connected with the main tunnels by cross-drifts dividing the latter into excavation sections 4 or 5 miles in length, which can be constructed independently of each other.

From experience with the trial drifts constructed, the seepage in the main tunnels is not expected to exceed 8 gal. per minute per 100 lin. ft. of single-track tunnel, or 26,500 gal. per minute for the entire length of both tubes, which is well below the quantity of water pumped in many of the deep mines of Europe.

TUNNEL TO BE BUILT IN SECTIONS

The French half of the work is naturally divided into two sections, the first of which includes the station and approach and the first 4½ miles of tunnel, which can be drained through the existing shaft. The construction plans contemplate building the remainder of the French section by first driving the drainage tunnel, from which three cross-tunnels will be excavated to the line of the main tunnels. From the end of each of these cross-drifts and from the end of the drainage tunnel at mid-channel the excavation of the main tunnels will be started upgrade, all of the spoil being taken out through the drainage tunnel and the main shaft. During the construction of the drainage tunnel and cross-drifts it is proposed to drill test holes up and down at intervals of 500 ft., to define exactly the limits of the stratum in which the tunnel will be constructed. This exploration work may result in modifying the proposed profile shown herewith.

Tunneling machines modeled on that invented by Colonel Beaumont and thoroughly tried out on the British side of the strait will be used to drive both the main tunnels and the 10-ft. drainage tunnels. It is expected from the past performance of this machine that a progress of 3.7 miles per year can be made for each machine in use, provided the muck can be disposed of. With all the headings working, this would require the transportation of 4400 tons of material daily through the section of drainage tunnel next the shaft. The French engineers expect to accomplish this with an electric railroad of 2-ft. gage (presumably double-track), over which 100 train movements a day in each direction will be necessary. This estimate also allows for transporting in and out 1200 workmen daily. A very large shaft will be necessary to accommodate hoisting equipment capable of raising material to the surface at this rate. Experience indicates that the shaft on the French side will be difficult to sink, and it is expected that the pneumatic process, grouting or freezing, or perhaps a combination of all three, will be required.



TWIN-TUBE SECTION ADOPTED

Based on this estimate of progress in the headings it would take three years to drive the drainage gallery to the center of the strait. In the meantime work would have started, at some of the four points of attack provided for, on the main tunnels. It is expected that by this method the entire work can be completed in 4½ or 5 years. The work on the British half of the tubes will be carried out along much the same lines, although the construction scheme for this half of the work has not yet been gone into so thoroughly as that for the French side.

ELECTRIC OPERATION DECIDED ON

As was to be expected, the contemplated use of compressed-air locomotives has been abandoned for electric operation. Numerous breaks in grade will not constitute a disadvantage with electric traction, and consequently it is planned to change the profile of the tunnels, as may be required, to insure keeping them well within the impervious stratum. It has been estimated that the train movements would be sufficient to ventilate the tunnel, but the plans provide in addition for two 300-hp. ventilators, each capable of changing the air in the tunnel once in three days without assistance from train movements.

VENTURE LIKELY TO PROVE PROFITABLE

Although it is estimated that the project would cost in excess of $2,000,000 per mile, a figure not approached by any other railroad tunnel in Europe, it is believed that the operating revenue to be derived from the enterprise would make it a profitable one from the outset. It would be possible, if terminal facilities could be provided to load them, to move 144 troop trains a day in one direction. If 1600-ton freight trains (representing about a 50-car train in American practice) were hauled, a possible volume of 225,000 tons of freight a day could be handled on the same basis. As the most recent estimate of Sir Douglas Fox places the cost of the English half of the tunnel at $31,655,000, and as Albert Sartiaux estimates that the French half can be built for $34,740,000, the net annual revenue from such maximum traffic at prevailing rates would represent a large fraction of this estimate for the entire cost of the project.

ESTIMATED CONSTRUCTION COST $77,000,000

To be on the safe side M. Sartiaux has supposed that the entire construction cost will amount to $77,000,000, and has made a conservative estimate of the proportion of the present freight and passenger traffic across the channel which would be diverted to the new line. On this basis 440 to 550-ton trains (corresponding to a 15 to 20-car American freight train) would be the standard for freight traffic, and fifteen freight and passenger trains would be operated each day in each direction. The net revenue on this traffic would yield 5 to 7 per cent on the sum invested. A similar estimate published by Baron Emil d'Erlanger in the *Evening Standard* also places the net annual earnings of the road at $5,400,000, which represents about 7 per cent on the maximum expenditure contemplated.

The tunnel, if constructed, will have a far-reaching effect in cementing French and English commercial relations. The line would bring Paris and London almost as close together as New York and Boston, and would reduce by 5½ hours the best running time that can be made at present. It would make it as easy for a London agent to visit points in northern France as for a New York salesman to reach the cities of Massachusetts. The most important saving, however, would probably prove to be the elimination of the double transfer from rail to water and back to rail, which is necessary at present, and a saving in the time required for the transit of freight shipments probably much greater than the saving in passenger time.

Number of Native Engineers Increases

The total number of engineers employed by the Bureau of Public Works of the Philippine Islands June 30, 1911, was 153, according to the annual report of the director. That number had been reduced to 98 by the end of 1915. In 1911 the number of engineers not natives of the islands was 143; in December, 1915, it had shrunk to 63. The total number of native engineers has increased from 10 to 35 in the same four years.

Bascule Bridge for Highway Service in California

Leaves Connected at Center Only by Bar to Equalize Shear, All Stress Being Carried by Cantilever Action

SACRAMENTO COUNTY in central California recently authorized the construction of a highway bridge across the Sacramento River between Walnut Grove and Grand Island. As the river is navigable at this point, it was necessary to maintain an unobstructed channel, and after a study of conditions it was decided to use a Strauss heel-trunnion type bascule bridge with two 113-ft. leaves. The leaves are designed to act as independent cantilevers, both live and dead load being balanced by a counterweight. No connection for transferring stress is provided at the junction of the leaves except a bottom-chord lock for equalizing shear.

SUBSTRUCTURE OF STEEL CAISSONS

The river bed at the selected site consists largely of sand and silt, and provision against scour was required. At high water the average depth is 38 ft. and at low water about 20 ft. The piers supporting the movable leaves were built by sinking steel caissons, 9 ft. in diameter, 49 ft. below extreme high water, sealed at the bottom with a concrete mixture 25 per cent richer in cement than the 1:3:5 mix used in the piers proper. Two such caissons were provided for each pier. Previous to the sinking of the caissons a cluster of timber piles had been driven for the piers and cut off above the concrete seal at the bottom of the caisson after it had been sealed and pumped dry. Wood forms were used for the upper portions of the piers, which at the top are 26 ft. long by 5 ft. wide.

Creosoted timber fenders spaced 13 ft. from the center line of bascule piers mark the limits of the 200-ft. clear channel and serve to protect the piers. Each fender is made up of four pile clusters with a row of piling between, faced with waling strips. The total weight of the superstructure steel in the bridge is about 260 tons, the weight of the machinery is about 26 tons, and the counterweights are about 210 tons each.

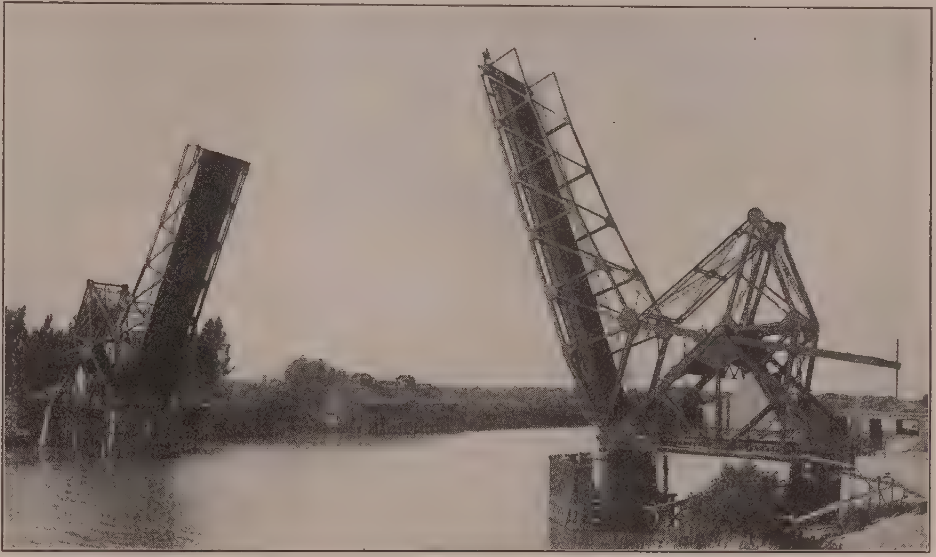
The bridge provides a roadway 6½ ft. above extreme high water and 18 ft. wide between curbs. The floor surface has a 3-in. creosoted wood-block paving laid on two layers of single-ply felt, well coated with asphaltic filler and laid on 1⅜ x 6-in. creosoted planking placed diagonally and supported on 4 x 6 in. transverse subplanking spaced 16 in. on centers and bolted to the steel stringers.

DESIGN AND OPERATION

The leaves are designed as Pratt trusses acting as cantilevers and have no connection at the center other than a lock bar below the floor system for equalizing shear. The operating strut shown in the photograph serves also as a live-load anchor arm. Its location in relation to the leaf and tower naturally lends itself to this purpose, and it only remained to design this member so as to carry the tension stress induced by the maximum live load on the leaf and to devise a satisfactory detail to anchor it to the tower when the leaf is closed.

This detail is an 8-in. turned pin secured to the operating strut by means of two collars with flanges riveted to each web of the strut. This pin projects beyond the webs far enough to carry irregular hexagonal nuts, any side of which can bear against the rear surface of the joint at the apex of the tower, which is made normal to the center line of the strut. Each side of the hexagonal nuts has a different radius, and as these range, by ⅛-in. variations, from 7¾ to 8⅜ in., the length of the strut can be varied within the range of ⅝ in., until an exact adjustment between the leaves and struts is effected. After adjustment the nuts are secured in position with a setscrew keying the collars to the pin which carries the nuts.

The leaves are operated by electric motors. In case the usual source of power fails, electric power can be supplied by a 40-hp. gasoline engine driving a 30-kw. generator set installed in the operator's house. For starting this gas engine compressed air is available at all times. Both leaves are operated simultaneously by means of a submarine cable interlocking all control apparatus.



BASCULE HIGHWAY BRIDGE OVER SACRAMENTO RIVER HAS 113-FOOT LEAVES

LEAVES LATCHED AT CENTER

When the leaves are closed the locking together is effected by a 5½ x 2-in. forged-steel latch bar driven by a 5-hp. motor, and the leaves are properly aligned against unequal expansion or contraction by metal-lined oak guides bolted to the ends of the chords. The electrical brake-control system developed for slowly stopping the closure of the leaves consists of a magnetic brake which automatically puts a drag on the mechanism after the current is shut off and thus compensates for the lack of exact speed regulation which the alternating-current motor does not permit. The control of the main lifting motors is interconnected electrically so that they cannot be started until the locks have been opened; and when closing the leaves the locking cannot be completed until the leaves have been fully closed.

The concrete counterweight which balances the movable leaves is mounted on steel trusses supported on trunnions at the apex of the triangular framing of the tower span. Each leaf is moved by means of a pair of rack-toothed operating struts, one end pin-connected to the leaf at the hip of the trusses, the other engaged by operating pinions located on the portal of the tower span. The pinion and rack are held in mesh by a triangular guide equipped with rollers bearing against the flanges of the strut and free to turn on the operating pinion shaft, supported by bearings secured to the two tower legs. The operating pinions are actuated, through a train of reduction gears, by one 15-hp. 220-volt 850-r.p.m. motor for each leaf. With this motor the leaf is raised to full height in two minutes.

In order not to interfere with navigation the bridge was erected in the open position, and when lowered for the first time the leaves met within ¼ in. of perfect alignment and within ⅜ in. of the same elevation. By adjusting anchor arms by means of the hexagonal nuts referred to in the foregoing the leaves were brought into exact alignment.

The bridge was designed by the Strauss Bascule Bridge Company of Chicago. Jenkins & Wells of Sacramento were general contractors for the work; the steel and machinery were fabricated by the American Bridge Company, the electrical equipment was installed by the Butte Engineering & Electric Company of San Francisco, and the entire work was supervised by Drury Butler, county engineer.

Rapid Progress on Twin Peaks Tunnel

The Twin Peaks tunnel work in San Francisco is progressing at a rapid rate, according to a recent report of City Engineer M. M. O'Shaughnessy, and will be completed in May, 1917. Only 3400 ft., or less than one-third of the total length of the tunnel, remains to be excavated, and practically all stations and other accessory construction have been finished. Several hundred workmen are employed at both ends in day and night shifts, and the progress of the completed bore is about 12 to 15 ft. per day from each end. About 3750 ft. have been excavated from the east portal and 4750 ft. from the west portal. The concrete gang follows the excavating crew closely, and sides, arch and invert are completed as fast as the heading advances. Pneumatic placing machines are used to expedite progress of the concreting. The two ventilating shafts from the tunnel to the surface above have been completed, and one of these is used for pumping out the seepage water, which is coming into the tunnel at the rate of 300,000 gal. per day.

Influence Lines as Deflection Diagrams

A New Method for Treating This Subject Is Developed and Its Application to Simple and Indeterminate Structures Illustrated

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THERE have appeared in the Engineering Record during the last two years a number of articles developing and applying the newer graphic methods of designing indeterminate structures (see Engineering Record of Aug. 28, 1915, page 258; Sept. 11, 1915, page 324; Dec. 18, 1915, page 762; Aug. 19, 1916, page 234). All of these methods may be reduced to a single fundamental principle which should form part of the working apparatus of every structural engineer. This principle is simply the identity between influence lines and deflection diagrams. This idea, once grasped, will be found an invaluable aid not only as a starting point for the solution of indeterminate structures but also in providing a new and helpful point of view for many of the more elementary problems of simple structures.

Applications of this concept to the construction of influence lines for reactions, shears and bending moments in simple beams, for stresses in a truss, and for the graphic solution of statically indeterminate structures are here illustrated and described.

INFLUENCE LINES ARE DEFLECTION DIAGRAMS

Every influence line is a deflection diagram. For a proof of this relation the reader is referred to an article by the writer in the Engineering Record of May 20, 1916, page 680. The principle there established may be generalized as follows:

The influence line for any reaction, shear, bending moment or stress is identical with the deflection diagram produced by a unit displacement at the point of application and in the direction of the desired reaction, shear, bending moment or stress.

APPLICATION TO REACTIONS

To illustrate the application of the foregoing principle, consider first the simplest problems in influence lines. Thus, to find the reaction at the end of any simple span, assume the end raised a unit distance while the other end remains on its support; the resulting deflection diagram, Fig. 1, is the familiar influence line for beam reactions. Similarly, to find the reaction at an intermediate pier between two simple spans or to find a floorbeam reaction, raise the middle support a unit distance with the adjoining supports unchanged to obtain a triangle for the usual influence diagram.

Fig. 2 represents a cantilever bridge with a central anchor span. To obtain the influence line for one of the pier reactions, *R*, the corresponding support is raised a unit distance and the resulting deformation diagram is the desired influence line.

APPLICATION TO SHEARS

To obtain the influence line for shears at any section of a beam, assume a unit shearing displacement at the section. As there is no rotation, the two segments of the beam must remain parallel. The resulting deflection diagram is given by ASTB, Fig. 3. Since the ends, A and B, resting on supports, must have zero deflections, they are joined by a closing line AB to complete the diagram.

Fig. 4 represents a beam with overhanging ends. To obtain the influence line for the shear at the support S, a unit shearing displacement is assumed at that section, the two segments of the beam remaining parallel. The resulting displacement diagram, ASTB, is the desired influence line.

APPLICATION TO BENDING MOMENTS

To obtain the influence line for bending moments at any point M of a simple span, assume a unit bending or angle change at the section, as in Fig. 5. Drawing the closing line AB, the desired influence diagram is obtained. Fig. 6 shows how the construction of the moment influence line in the span AB may be modified to keep the closing line horizontal, at the same time extending the application of the construction to the case of a cantilever bridge.

APPLICATION TO STRESSES IN A TRUSS

The foregoing examples indicate how the principle here discussed may be utilized to endow the simplest influence lines with an added meaning. A more novel extension of the principle is in the construction of influence lines for the stresses in a truss. For this purpose the principle may be restated as follows:

The influence line for the stress in any member of a truss is identical with the deflection diagram produced by a unit elongation of that member.

This relation was established in the article by the writer previously cited. In application it is advisable to assume a unit shortening of the given member, instead of a unit lengthening, thereby inverting the resulting diagram, in order to provide for the fact that positive influence ordinates are measured upward, while positive deflections are measured downward.

To apply this principle to any truss member, proceed as follows: Assign to the given member a unit contraction, while all the other members remain unstrained. Find the resulting deflections by means of a simple Williot diagram and project them to the panel points of the truss to obtain the desired influence line.

EXAMPLES OF METHOD APPLIED TO A TRUSS

Fig. 7 shows the application of the above-mentioned method to a truss with subdivided panels, the influence lines for four different members being constructed. In each case the entire truss to the right of the member is first assumed fixed and is therefore represented by a single point (5, 6, 7, 8, 9, 10) in the Williot diagram. The contraction of the given member is represented by a heavy line of unit length, and the remaining points are found by drawing light lines perpendicular to the directions of the members in the usual manner. Projecting the points thus found to verticals below the panel points of the truss, the deflection diagram 0-3-4-5-10 is obtained. A closing line is drawn through the end points (0, 10), since the ends of the span have zero deflections. The resulting figure is the influence diagram for the member, the areas above and below the closing line giving + and — areas respectively.

As seen in the foregoing examples, the Williot diagram will generally be a simple figure on account of the zero deformations in all but one member of the truss. To further simplify the construction, if there are several panels to the left of the one containing the given member, they may be replaced by two straight lines connecting that panel with the end of the truss.

It may be noted, in passing, that the closing line introduced in the foregoing examples is another short cut; it takes the place of the rotation correction which is ordinarily made in the Williot procedure by means of an auxiliary truss diagram. It will be found instructive to apply the foregoing construction to various members of trusses with K-system or triangular bracing and to trusses with multiple systems of web members.

ADVANTAGES OF THE METHOD APPLIED TO A TRUSS

The above-cited method of constructing influence lines for trusses, although not intended to replace the older methods, possesses certain advantages over them. In the first place, it is completely graphic—instead of merely representing moments or shears from which the stresses must be figured analytically, it gives those stresses directly, making automatic correction for such factors as lever arms and secants of inclination. In the second place, it is absolutely general, dispensing with the necessity of remembering different rules for constructing different influence lines. It gives the influence lines for new or uncommon truss systems or combinations of members without requiring first an analysis of their stress relations. In this last advantage the method probably finds its chief usefulness, inasmuch as it furnishes an additional tool for the attack of unfamiliar truss problems.

APPLICATION TO INDETERMINATE STRUCTURES

This same principle, furthermore, forms the basis for the graphic solution of all statically indeterminate structures. It constitutes a bridge to pass from the study of simple influence lines to the subject of indeterminate systems. For example, if the beam in Fig. 1 is restrained at one end, a unit displacement of the other end will strain the beam into the familiar elastic curve of a cantilever beam, as represented in Fig. 8. This curve is the influence line for the reaction *R* at the free end of the beam, thus replacing the straight line of Fig. 1.

In a beam continuous over three supports a unit displacement of one end produces the elastic curve shown in Fig. 9, and a unit displacement at the middle support produces the elastic curve shown in Fig. 10. These deflection curves are the influence lines for the respective reactions. Each half of the curve in Fig. 9 or Fig. 10, referred to the tangent at B, is identical in form with the basic elastic curve shown in Fig. 8 and may be plotted with its ordinates. In general, the influence line for the reaction at any support of a continuous bridge is simply the elastic curve produced by removing the support and applying a load to give the point a unit vertical displacement. The application of this principle to the design of the Sciotoville Bridge was presented by the writer in the Engi-

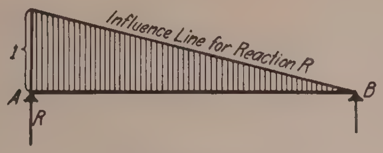


Fig.1-Simple Span

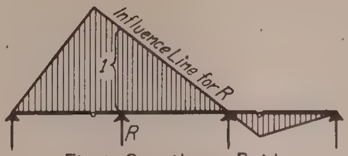


Fig.2-Cantilever Bridge

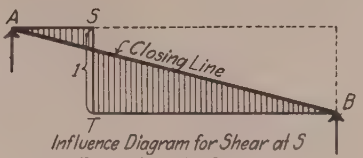


Fig. 3-Simple Span

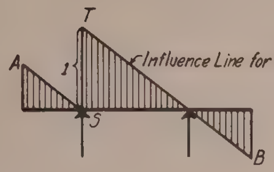


Fig.4-Beam with Overhanging End

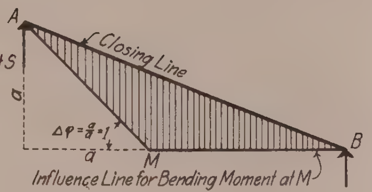


Fig. 5-Simple Span

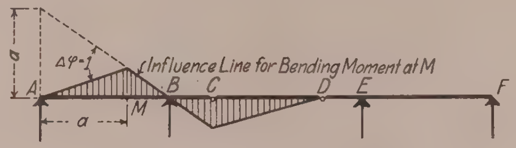


Fig.6-Cantilever Bridge

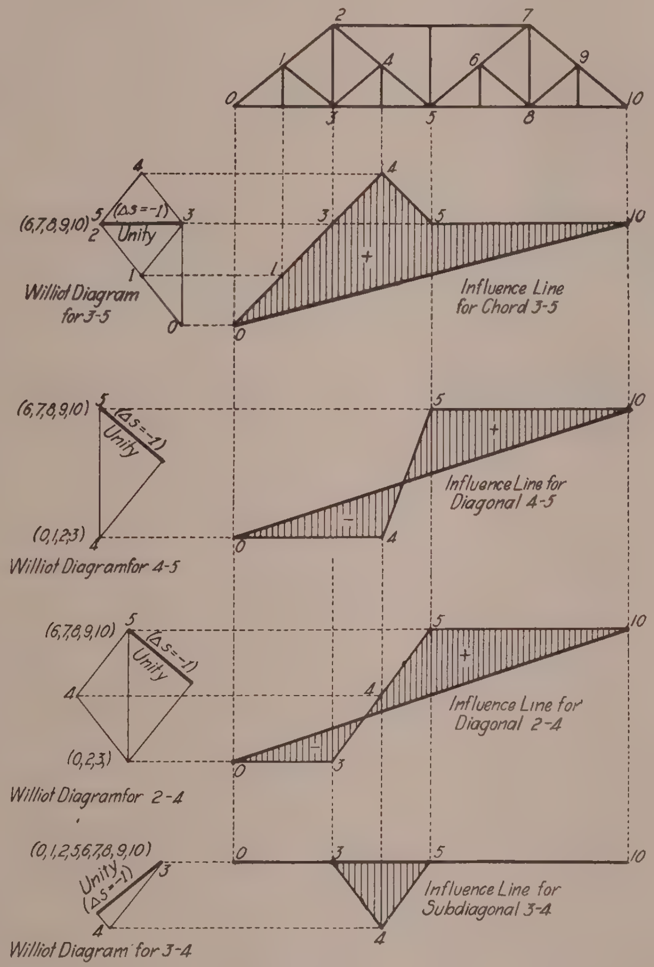


Fig.7-Influence Lines for Truss, with Subdivided Panels

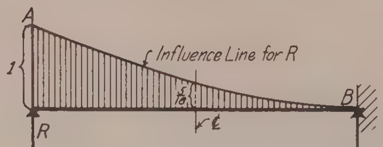


Fig 8-Beam with One End Fixed

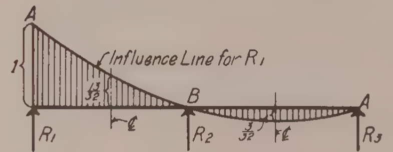


Fig 9-Beam Continuous Over 3 Supports

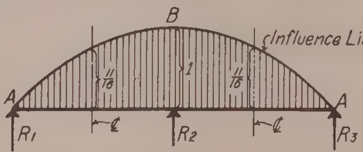


Fig.10-Beam Continuous Over 3 Supports

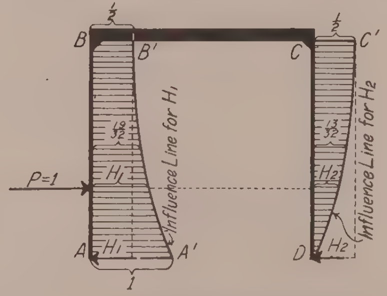


Fig.11-2-Hinged Portal Frame

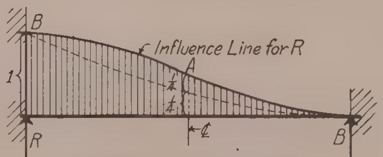


Fig.12-Beam Fixed at Both Ends

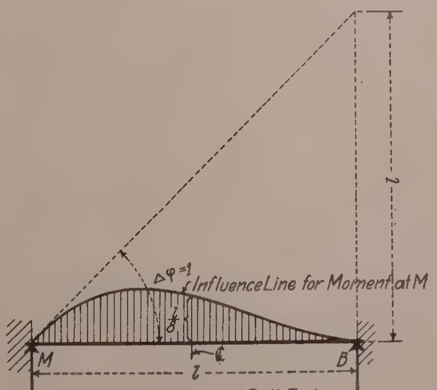


Fig.13-Beam Fixed at Both Ends

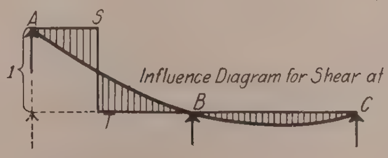


Fig.14-2-Span Continuous Beam

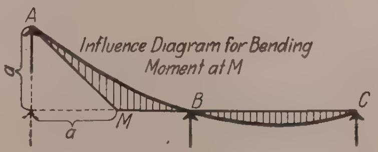


Fig.15-2-Span Continuous Beam

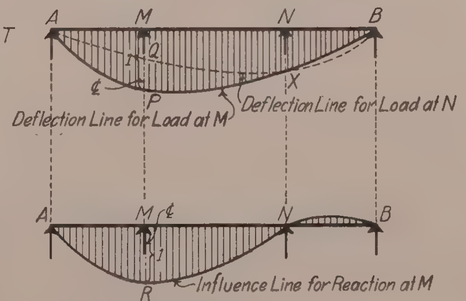

A
M
N
B
Q
1
℄
P
X
Deflection Line for Load at M
Deflection Line for Load at N
A
M ℄
N
B
1
R
Influence Line for Reaction at M

Fig.16-3-Span Continuous Beam

INFLUENCE LINES APPLIED TO THE SOLUTION OF VARIOUS PROBLEMS, INCLUDING STATICALLY INDETERMINATE CASES neering Record of Aug. 28, 1915, page 258.

In the case of arches, the influence line for *H*, *V* or *M* at one end is obtained as the deflection diagram produced by giving the end a unit horizontal, vertical or rotational displacement respectively. This principle was applied in the Engineering Record of Sept. 11, 1915, page 324.

In the case of a suspension bridge, the influence line for *H* is the deflection diagram of the stiffening truss produced by a unit shortening of the cable between anchorages. This principle was applied in the Engineering Record of Aug. 19, 1916, page 234.

An interesting illustration of the principle here discussed is afforded by the problem of a portal or rectangular frame, ABCD, Fig. 11, subjected to horizontal loads. Neglecting bending or compression in the top member, a unit horizontal displacement of A will make the frame assume the form A′B′C′D. Here the curves A′B′ and C′D are identical with the elastic curve of Fig. 8, and constitute the influence lines for the horizontal reactions at A and D. Thus, for a unit load applied at *P*, the horizontal intercepts H_1 and H_2 give the respective horizontal reactions.

Combinations of Deflection Diagrams

In a beam fixed at both ends, a unit vertical displacement at one end, without rotation, produces the deflection curve BAB, Fig. 12, as the influence line for the end reaction. Each half, BA, of this curve is identical with the basic elastic curve BA of Fig. 8. In the same beam a unit rotation at one end, without translation, yields the deflection curve Fig. 13 as the influence line for end moments. The ordinates of this curve may be obtained as the intercepts between the parabola shown dotted and the elastic curve BAB in Fig. 12. The former represents the deflections of a cantilever beam subjected to a bending moment applied at the free end; the latter represents the deformation of the beam required to restore the free end to its initial position. The differences between the respective ordinates therefore represent the resultant displacements of the beam and are plotted in Fig. 13 to enlarged scale.

Synthesis of Diagrams

In many cases, as in the foregoing example, the influence line or deflection diagram is best obtained by the synthesis of simpler deflection diagrams.

Another illustration is shown in Fig. 14, representing the influence line for shear at a section S in a two-span beam or girder. The broken line ASTC represents a unit shearing displacement; to bring the point A back to its support, an end reaction is evolved at A which produces deflections represented by ABC. These must be subtracted from the first set of deflections to obtain the resultant displacements or influence ordinates. In a similar manner a combination of the deflection diagrams of Figs. 5 and 8 yields the influence line for bending moments shown in Fig. 15.

The device of synthesis of deflection diagrams is particularly useful in the case of structures indeterminate to the second degree or higher. Thus, let it be required to construct the influence line for intermediate reactions in a three-span beam or girder, AMNB, Fig. 16. First consider both supports M and N removed and a unit load applied at M; the resulting elastic curve is APXB. Next, to restore X to its original position, a reaction is evolved at N. A force at this point would produce an elastic curve AQXB, shown in dotted lines. The differences between the ordinates of the two curves give the ordinates of the desired influence line ARNB. Although this deflection curve, like that in Fig. 13, could be roughly sketched at sight, the procedure just outlined is a simple method for accurately obtaining the ordinates for the desired line.

Whether structures are designed by the method of least work or by the principle of virtual velocities, two methods which are essentially the same in actual procedure and differ only in appearance or interpretation, the graphic design ultimately resolves itself into the problem of constructing influence lines. For this purpose the simplest and most direct method of attack, one which will help to visualize the problem instead of obscuring the immediate issue by the use of mysterious looking formulas is provided by the concept here developed—namely, that every influence line is a deflection diagram.

"Panama Canal Slides Will Be Overcome for All Time"—General Goethals

In His Latest Annual Report the Governor of the Canal Reviews History of Slides and Answers Criticisms of Work at the Isthmus

"AS predicted at the time the great Culebra movements occurred, the slides will be overcome finally and for all time, notwithstanding the calamity howlers and in spite of the disastrous predictions of the 'know-it-alls.'"

With these words Major-Gen. George W. Goethals, governor of the Panama Canal, in his annual report for the year ended June 30, 1916, concludes a discussion of the slide situation at the isthmus. Although this question has been dealt with in previous reports and official documents, General Goethals believes that misconception regarding the slides is so general, due to the publication of erroneous information from various sources, that he is justified in reporting upon the matter again, even at the expense of repetition. He takes a fling at several of the Panama Canal's critics, among them Prof. Benjamin Le Roy Miller, of Lehigh University, and ex-United States Senator Thomas Kearns, who believes "that the whole trouble is caused by subterranean gases formed in the earth, which, when permitted to escape through certain channels or breaks in the earth, carry with them eruptive material, sometimes for a long distance, to the place of least resistance."

History of Slides Reviewed

General Goethals enters rather fully into the history of the Panama slides, much of this ground having been covered in his official statement published in the Engineering Record of Nov. 27, 1915, page 652. Gaillard Cut, he explains, extends from Pedro Miguel to Gamboa, a distance of 8.75 miles. The canal prism through this section averages 300 ft. bottom width, and has a depth of 45 ft. Every foot of the existing channel was excavated through rock, all of which, though of various kinds and densities, had to be drilled and blasted in order to remove it. It is possible that the water may have softened some of the material, yet it is known that the softer varieties of rock encountered in the excavation were protected from disintegration by contact with water. The bog theory is a myth. The cut has been stable with the exception of the portions in the vicinity of Culebra and at Cucaracha. The slides at Culebra are on both sides of the waterway, occupying a length of 2800 ft., while the channel affected by the Cucaracha slide is less than 2000 ft. long, so that out of a total length of 8.75 miles only 0.88 mile is affected.

A misconception that exists relates to the character of the slides. They have not been, except in part at Cucaracha, a slipping down of portions of a bank in order to reach the slope at which the material will stand. Slides of this character have occurred, but they were small in extent and easily handled. Those at Culebra are breaks resulting from deformation or crushing of underlying strata which, under changed conditions, could not bear the weight of the superimposed mass, and caused a vertical settlement or drop of the overlying material, which subsequently moved into the prism. Final rest will be secured when all the material that is in motion has ben removed. As is shown by experience with smaller breaks that have occurred from the same cause, when the end is reached the final surface will be concave, or bowl shaped.

Scientists' Committee Investigates

General Goethals takes issue with Professor Miller, who is quoted in a press item as having said: "For many years to come the rainy season is almost certain to cause such slides as to close the canal for weeks or even months." Speaking of the investigating committee from the National Academy of Sciences appointed late last year by President Wilson, General Goethals says: "It was anticipated that the committee from the National Academy of Sciences would make a more thorough examination than Professor Miller had done, and it was hoped that, as a result, the statements of Prof. Benjamin Le Roy Miller, Ph.D., would be found to be what we considered them—erroneous, unwarranted and unfair, and help restore the confidence that he had helped to destroy.

"The preliminary report by the committee of the National Academy of Sciences was submitted to the President in January, 1916. At that time they expected that their final report would be completed in April, but up to date it has not been received. It will be noted that the statement made by Professor Miller, that practically all Gold Hill and much of Zion Hill must be removed, is not concurred in; and in this connection it should be remembered that a committee of this character expresses its opinions guardedly, for whatever happens they must be found on the right side. They advocated, as a matter of scientific interest, the making of an accurate triangulation of the hills in question—Gold, Contractors, Culebra, and Zion—which has been done. By checks made at frequent intervals the slightest movement on the part of any of the four hills would be disclosed at once. No movement of any kind has taken place."

The committee expressed the belief that every available and practicable device for controlling the water, both on the surface and underground, should be employed, and to this end advocated covering the slopes with vegetation to prevent surface wash, closing peripheral cracks, draining undisturbed and threatened areas, and draining by tunnels.

MEASURES TO PREVENT SLIDES

General Goethals reviews the measures taken to prevent slides, including the covering of slopes with vegetation, the closing of peripheral cracks in rock with sluiced earth, the installation of drains, and other expedients that have been proposed by the various investigators.

It is admitted, says General Goethals, that if the water could be entirely excluded the earth movements would cease, but unfortunately this is impossible. With the heavy tropical downpours the best that can be done is by drainage, to carry away what falls as rapidly as possible, but ground water cannot be eliminated. So far as concerns ground water, the construction of the canal has created entirely new conditions. The old tributaries of the Chagres River and those of the Rio Grande, which formerly were natural drains, are now well above the water surface of the canal, and the canal has become the drainage channel for the country for miles on either side. Even assuming that it were possible to devise a system for getting rid of ground water, it must still exist below the surface of the water in the canal itself. The slides in question affect the banks for a considerable distance down, probably below the bottom of the canal, and if ground water be primarily the cause, then it cannot be removed from the strata at which the trouble starts.

DRAINS IMPRACTICABLE

So long as the slides are active and the configurations of their surfaces change as rapidly as they now do, it is impracticable to open and maintain the permanent drains recommended in the moving areas. When equilibrium is restored, and as a means of promoting permanent stability, the drains of a permanent character should be constructed and maintained.

On the subject of proposed drainage tunnels Donald F. McDonald, geologist, reported as follows: "While the sliding rocks have a high percentage of pore space, the pores are mostly of capillary size and are filled with water which obeys the laws of capillarity and which cannot therefore be drained off. These experiments definitely established that all cures by drainage which had been offered to and urged on the canal authorities were absolutely futile, and the money which might have been wasted in worthless tunnels, wells and acres of asphalt covering was saved for the only remedy that could bring permanent cure under the circumstances—dredging."

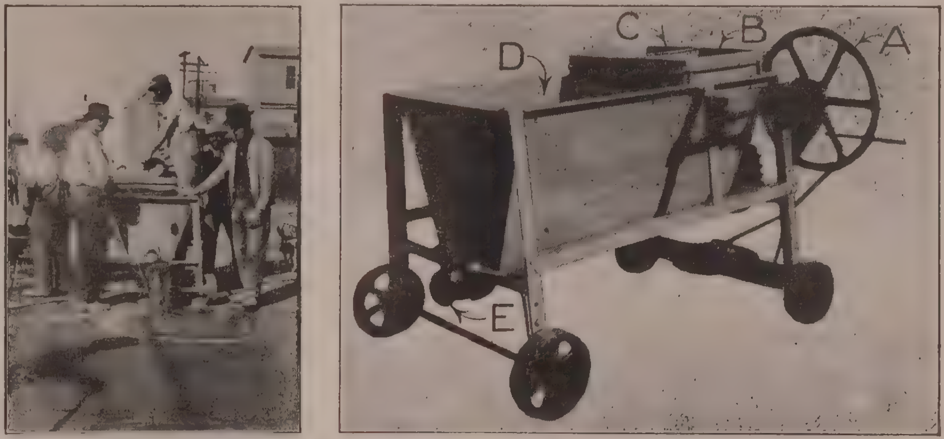
General Goethals concludes his report by commenting upon some of the extravagant theories which have been advanced to account for the slides. One is that a huge reservoir of water exists within the earth and that the pressure therefrom produces the slides. The mutual attraction of the large masses on either side of the cut is assigned as the cause for bringing down the material, while one critic believes that the trouble is due to the fact that "a huge magnet that previously existed has been cut in two."

City Engineer Designs Paving-Grout Mixer

Apparatus on Wheels Is Equipped with Paddle for Agitating Materials and Securing Uniform Mix

THE accompanying illustrations show the main features of a paving-grout mixer which has been designed by A. W. Hall, city engineer, of Jackson, Mich. It is claimed to produce a more satisfactory product than is obtainable by hand-mixing methods. A feature of the device is a paddle wheel which may be revolved through a chain drive by the hand wheel *A*, thus agitating the grout mixture and insuring its homogeneity. Cement is placed in the hopper *B* and sand in the hopper *C*. Each of these compartments has a capacity of 1 cu. ft. The ingredients fall by gravity into the mixing tank *D*, where water is added by a hose. The outlet *E* for the mixed grout is controlled by a hand-operated valve.

This equipment, it is said, has effected a substantial reduction in the cost of mixing and placing grout for the brick pavements of Jackson.



PORTABLE GROUT MACHINE IS EQUIPPED WITH HAND-OPERATED STIRRING PADDLE

San Diego, California, Makes Repairs to Its Wood Pipe and Tunnels

Repair of the San Diego (Cal.) water system includes retimbering the four tunnels and rebanding the wood-stave pipe which runs through them. The work is being finished at a cost of $16,700. The 22-mile wood-stave line varies in size from 40 in. at its intake to 24 in. where it discharges into the University Heights reservoir in San Diego. As it is the main line connecting the impounding and the distributing systems its upkeep is of vital importance. Nothing had been done to the pipe or tunnels since they were built eight years ago. Two of the tunnels were found to be higher at both ends than in the middle. All have now been graded so that the drainage is excellent, and with the new timbering just placed it is almost impossible for them to become clogged. Everything has been done with a view to keeping the tunnels dry and carrying away any water which may leak from the main. The aggregate length of the four tunnels is 6733 ft. That length of 36-in. pipe had to be rebanded and in some places new staves put in. For the rebanding of the pipe the city purchased 18,000 new bands at a cost of $4,660. The entire job will be finished this year. This information was furnished by A. C. Francis, of the operating department of San Diego.

Stress Distributed Unequally to Rivets of a Joint

Theoretical Analysis and Results of Tests Made by Professor Batho Show That First and Last Rivets Get Higher Stress

THAT the first and last rivets in a riveted connection take by far the greatest proportion of the total load is indicated by the theoretical analysis and checked by results of a short series of tests (five rivets on each side of the joint) presened by Cyril Batho, assistant professor of applied mechanics, McGill University, Montreal, in a 50-page paper in the *Journal* of the Franklin Institute for November. While admitting that further experimentation is necessary, particularly to determine general laws for a variable *K* entering the equations and to find whether the joint acts by friction between the plates or by shear on the rivets, Professor Batho shows that close agreement between his analysis and the test results now available seems to prove the soundness of his theory, which is based upon the principle of least work. The practical importance of his conclusions is evident in view of the universal assumption in design that all rivets carry equal loads. These conclusions are as follows:

SUMMARY AND CONCLUSIONS

"1. It is shown that a riveted joint may be considered as a statically indeterminate structure, and that a series of equations may be obtained for any joint by means of the principle of least work, giving the loads carried by each of the rivets in terms of a quantity *K*, which depends upon the manner in which work is stored in, or by the action of, the rivets.

"2. This theory is applied to various types of joints, and the modifying effects of non-uniform distribution of stress in the plates, unequal partition of the load between the two cover plates, and a difference in the modulus of elasticity of the middle plate and the cover plates are also considered.

"3. It is shown experimentally that extensometer measurements on the outer surfaces of the cover plates of a riveted joint are sufficient for the determination of the mean stresses in the plates, and that the partition of the load among the rivets may be determined from such measurements. It is also shown that, at any rate after the first few loadings, the distribution of strain in the plates of a joint is not altered by repeated loadings.

"4. It appears from 3 that if there is any frictional hold between the plates, it acts only over those portions in the immediate neighborhood of the rivets. All the experiments tend to show that friction does not play an important part, but further experiments are necessary on this point.

"5. Experiments made on a number of specimens having a single line of rivets and loaded in tension give results in close agreement with the theoretical considerations. They also show that the longitudinal stresses in a portion of the cover plate between two consecutive rivets are a minimum along the line of rivets, rising to a maximum at the edges of the plates.

"6. The experiments show that the value of *K* for a joint having a given ratio of width of cover plate to rivet pitch and a given number of rivets varies approximately directly as the load and inversely as the area of the rivets. An empirical rule is given for its value in joints similar to the experimental specimens, but a more general rule cannot be given until further experiments have been made. A theoretical estimate is made of the value of *K* for a rivet acting in shear, and the result is shown to be within the range of the experimental values.

"7. Both the experimental results and the theoretical deductions show that: (a) In a double-cover butt joint having a single line of rivets, the two end rivets and the two rivets on each side of the junction of the middle plates take by far the greater part of the load at all loads within that causing permanent deformation of the plates or rivets, the actual proportion decreasing slowly as the load increases; (b) if, in such joints, the total area of cross-section of the cover plates is equal to that of the middle plates, these four rivets take equal loads, but if it is greater the end rivets take greater loads than the others, the difference increasing as the area of the cross-section of the cover plates increases; (c) if two plates of uniform width and equal thickness are connected by a single line of rivets to opposite sides of a gusset plate of uniform width, the first and last rivets take the greater part of the load, but if the gusset plate increases in width from the first to the last rivets, the partition of load is more uniform."

Resident Engineers Study Moot Drainage Problems

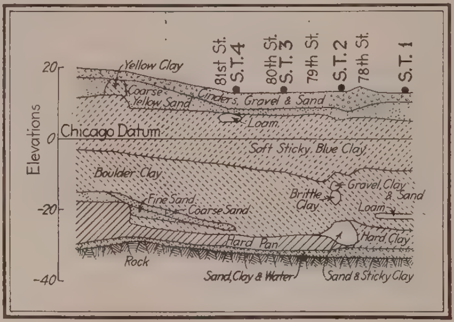
Staff meetings of the large engineer corps of the Little River Drainage District of Missouri are held bimonthly to discuss questions on which there are few or no printed data with reference to certain changes that occur in canals after construction, such as sloughing, breaking of banks, caving and shoal formation. The extent of the works of the district is so large that it affords an admirable opportunity to study the various conditions which are conducive to the changes noted. To make definite the field of research for each man, the chief engineer, William A. O'Brien, appointed resident engineers to report progress and make a study in the field of the following subjects: E. S. Blaine, deterioration of ditches; H. V. Newcomb, spoil areas required and clearing; V. H. Henderson, proper openings under large spoil banks; L. D. Sheppard, excess excavation, and Blair Boyle, protection of banks. The study of these topics will continue during the construction period or until all information that it is believed can be obtained has been secured and carefully tabulated.

Soil-Bearing Tests Determined Loading on Chicago Track-Elevation Work

Investigation Deemed to Justify Loads of 3900 Pounds Per Square Foot on Clay or Sand—Such Loads Have Caused Little Settlement

By R. H. FORD
Engineer of Track Elevation, Chicago, Rock Island & Pacific Railway, Chicago

ON ACCOUNT of the great weight of the concrete retaining walls necessary to support the elevated grade of the Chicago, Rock Island & Pacific Railway, caused by the separation of grades between the Rock Island and the Chicago & Western Indiana Railroad at Seventy-ninth Street, Chicago, a special study was made of the bearing power of the soil, as preliminary calculations showed that the soil would be loaded approximately ten times greater than is ordinarily the case with track elevation. As a result of the test, loads of 3900 lb. per square foot were allowed on clay or sand, and in the two years that the walls have been standing no appreciable settlement or cracks have been noted.



RELATIVE THICKNESS OF STRATA

Preliminary tests were made by borings during September and October, 1912, a soil auger being used, so arranged as to decrease in size from 4 in. to 1 in. These borings showed six different strata. Rock is overlain with hardpan and this in turn is overlain by a sheet of thin blue clay; above the clay is a stratum of glacial drift, which is characteristic in this territory; and above the drift comes soft, sticky clay with a covering of coarse yellow sand, while the surface layer is composed of various materials which have been used from time to time for roadbed filling.

Owing to the uncertainty of the bearing power of the mixed deposit above described, the series of soil-bearing tests was also made. For this purpose test pits were dug large enough to get a level bearing on the bottom of the pit of sufficient size for the bearing plate of a specially constructed loading frame designed as shown in the accompanying photograph. The bearing plate was 2 ft. square, made of ordinary 3-in. lumber and surmounted by four vertical 6 x 8-in. bridge ties. A horizontal loading platform 6 x 6 ft., of 3-in. lumber, was then placed on top of these posts, and the entire structure was thoroughly bolted to secure rigidity. At the ground level a frame or curbing was set so as to prevent overturning in case of unequal settlement, and an allowance of ¼ in. was left to prevent binding with the posts. This curbing was secured in position by stakes driven at the end of the 3 x 8-in. planks, 16 ft. long, of which it was constructed. Pig iron was used on the loading platform, each piece being weighed separately and the weight being painted thereon.

The amount and rate of settlement were determined with a Y-level and an 11-ft. rod, the foot of the rod being placed on the bearing plate and extending up through the loading platform. Before the tests were begun a bench was located a short distance from the apparatus.

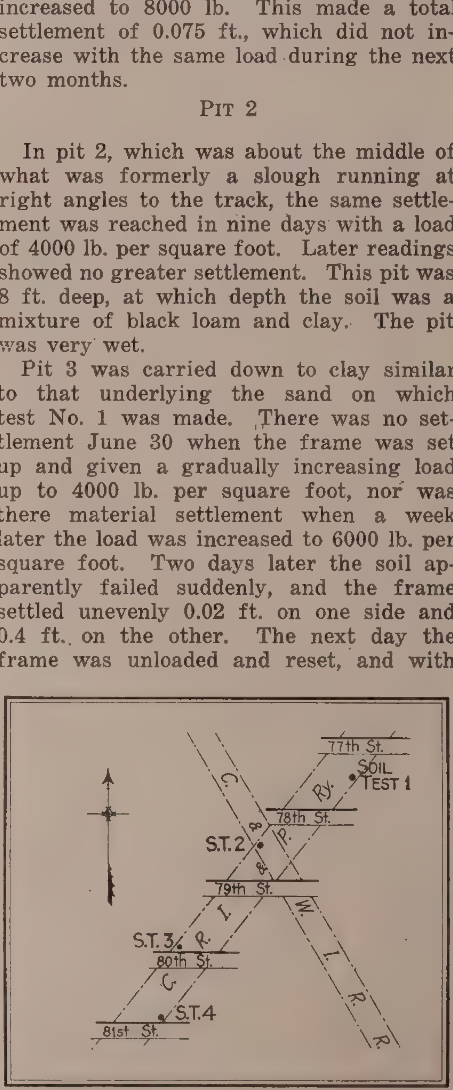
The accompanying drawings show the location of the boring and test pits, and also the soil strata. Four test pits were used, the tests beginning in April, 1913, and the last one being terminated in July of the same year.

The first pit was 6 ft. deep. At the bottom was 2 ft. of fine yellow sand, overlying clay. The water in the pit was 6 in. deep. There was an initial settlement of 0.007 ft. with a load of 500 lb. per square foot, a further settlement of 0.019 ft. two days later when the load was increased to 3000 lb. per square foot, a settlement of 0.025 ft. two days later when the load was increased to 5000 lb., a settlement of 0.01 twelve days later when the load was raised to 6000 lb., and a settlement of 0.015 ft. three days later after the load had been increased to 8000 lb. This made a total settlement of 0.075 ft., which did not increase with the same load during the next two months.

PIT 2

In pit 2, which was about the middle of what was formerly a slough running at right angles to the track, the same settlement was reached in nine days with a load of 4000 lb. per square foot. Later readings showed no greater settlement. This pit was 8 ft. deep, at which depth the soil was a mixture of black loam and clay. The pit was very wet.

Pit 3 was carried down to clay similar to that underlying the sand on which test No. 1 was made. There was no settlement June 30 when the frame was set up and given a gradually increasing load up to 4000 lb. per square foot, nor was there material settlement when a week later the load was increased to 6000 lb. per square foot. Two days later the soil apparently failed suddenly, and the frame settled unevenly 0.02 ft. on one side and 0.4 ft. on the other. The next day the frame was unloaded and reset, and with



LOCATION OF TEST PITS

4000 lb. there was no settlement. On the following day, however, before 6000 lb. per square foot was reached, the frame leaned badly, and it was necessary to prop it to prevent overturning. The vertical settlement was 0.42 ft., all of which took place in a few minutes.

The clay at the bottom of pit 4 was similar to that at the bottom of pit 3, but did not contain so much sand. It was very wet at the time the test was made, as there was 5 ft. of water in the hole during the whole time. After two weeks there had been a settlement of 0.43 ft. with a load of 4000 lb. per square foot.

The tests indicated safe loads as shown in Table 1.

Standing water from surface and seepage water was at all times in the pits. Observations during the tests indicated that the area of the bearing plate was too small, and the soil squeezed out from under the plate, which was a condition not met with in the wall construction. The foundations on which the wall would rest would consist of clay in all cases. Taking these things into consideration, combining them with the data secured from the borings with the soil tests, and comparing this information with the weight of the soil of structures in the vicinity, especially the buildings of the International Harvester Company, the loading of which is approximately 4800 lb. per square foot, the loads in Table 2 were finally determined upon.

PIG IRON TO THE DESIRED WEIGHT WAS PILED ON A 6 X 6-FOOT PLATFORM

TABLE 1—SAFE LOADS INDICATED BY TESTS

Material	Loads, lb. per sq. ft.
Loam mixed with clay	1000
Clay when wet (as in pit 4)	1000
Clay when moist as ordinarily found (pit 3)	2000
Clay confined	2000

TABLE 2—LOADINGS ALLOWED

Material	Loads, lb. per sq. ft.
Clay, when wet or dry	3900
Sand	3900
Loam mixed with clay Foundation to be lowered to clay	

On the basis of the loading in Table 2, 1700 ft. of walls, varying in height from 5 to 20 ft., were constructed, and the results carefully studied in the light of these tests, and no appreciable settlement or cracks have been noted. A study of the bearing power and soil conditions during the succeeding two years indicates that the safe loads adopted were warranted. It is believed that where the ground remains continuously wet, as in the case of large amounts of rain after foundation excavations have been prepared, causing soft clay to remain wet for a considerable time previous to construction, the liability of initial settlement is materially lessened by the use of crushed stone or gravel of a sufficient depth to overcome the softening due to standing water. Investigation shows that usually from 2 to 4 in. is soft due to these causes, irrespective of the depth to which the excavation has been made preparatory to construction.

Road-Building Methods of New York State Criticised; Deputy Commissioners Reply

D. T. Pierce Bases Comment Upon Inspection of 2200 Miles of Road—H. E. Breed and F. W. Sarr Take Issue with Some of His Statements

THE Engineering Record has received the following comment on the condition of New York State highways. Copies were sent to the first and second deputy state highway commissioners, whose replies are given below.

Notes on New York Road Conditions

By DANIEL T. PIERCE
Executive Assistant, Barber Asphalt Paving Company, Philadelphia

A recent survey of 2200 miles of New York state roads suggests some comments which may be of use to road builders elsewhere.

At many points throughout the state there are encountered gangs of men cutting out sections of recently improved roads for the purpose of putting in drainage and telford support, the necessity for which had become painfully evident. Practically all of this work should have been done before the improved road was built. To wait until weak spots develop in a road before providing adequate drainage or support is very much like waiting until the wall of a house sags or cracks and then strengthening the foundations.

It is hardly conceivable that 3 or 4 miles of road will have the same sub-base conditions and can safely be built on the same foundation throughout. Yet this is apparently what has been done and is being done. A few dollars in "extras" for taking care, during construction, of spots where weakness in the support of a road surface is likely to develop will evidently save heavy expense in correcting such weakness after a road is completed.

SURFACE TREATMENT FAULTY

Insufficiently and improperly covered surface treatments are to be observed all over the state. As to bitumens employed, light hot oil appears to have the preference this year in place of the tar that was liberally employed in 1915. In many places what is called "sand" is used for covering both oil and tar. This upon examination is found in some cases to contain varying quantities of clay and loam. The results obtained, even when the sand is clean, are such as to confirm the well-known fact that only very coarse sand is suitable for covering surface applications. Where stone chips are used the quantity is insufficient. The state calls for 50 tons of stone chips per mile of 16-ft. road. This is not enough to permit integration or bonding. The spectacle of a ½-in. stone chip in lonesome isolation surrounded by 2 or 3 in. of uncovered oil is a spectacle that produces, according to temperament, either amusement or grief.

From careful observation of results the conclusion must be drawn that quite different surface treatments should be applied to plain macadam and asphalt penetration roads. The surfacing of plain macadam with light oil appears to give very good results. The same treatment of penetration roads in many cases results in unduly softening the original road and consequent mushing and rutting. As an example of this condition may be cited the Ballston road (No. 5062), part of which is in the village of Ballston. The latter portion has not been oiled and is in far better condition that the 2½ miles of the road outside the village that have been oiled. Although built in 1910 by the penetration method, the section in the village of Ballston is in almost perfect condition, while so much cannot be said of the section outside of the village where the traffic is lighter.

A similar condition is encountered on the Craryville-State Line road (No. 762), another penetration highway built in 1911. It is evident that resurfacing with light oil has resulted in mushing up the surface of this road, notwithstanding which a contract for reoiling with a light cold oil has been let. Where resurfacing or seal coating has been carried out with heavy asphalt cements in place of the light oils usually employed, the results are uniformly much better than those obtained with the lighter materials.

FLAT ROADS THE BEST

Although high crowns on bituminous roads have generally been abandoned, it may be of interest to road builders to note that New York's experience strikingly confirms the wisdom of building bituminous roads with almost flat surfaces. Judging by the condition of some twenty-five roads, the ideal section is one with not more slope toward the crown than is absolutely necessary for surface drainage; and, as is well known, with a smooth and impervious surface only a very slight crown is necessary for this purpose.

A considerable number of roads built prior to 1912 were originally designed to be waterbound macadam. They were changed to bituminous construction without alteration being made at the same time in the cross-section. In other words, they were built with the same crown that they would have had if constructed of plain macadam. The bituminous highways in the neighborhood of Elizabethtown afford an excellent opportunity to observe the comparative wearing qualities of high crown and flat roads. The flat roads are uniformly in much better condition than the others, one notable example of the better wearing qualities of the flat road being highway No. 5117, 6 miles of penetration consisting of a 3-in. top on but 3 in. of broken-stone base. This was built in 1912 at a cost of 87.2 cents per square yard, and is in almost perfect condition now. Not only does the high-crown road encourage driving in one track and consequent rutting, it also seems to be more susceptible to other forms of disintegration, the relation of which to the shape of the road is more or less a mystery.

Second-Class Concrete

It will occasion no surprise, nor need it give concrete-road advocates any particular concern, to know that the so-called second-class concrete roads built in New York from 1912 to 1914 have gone all to pieces. These roads were built with a 1:3:6 mix. If proof is needed that such a mixture is foredoomed to failure it may be found in the present condition of the concrete road (No. 5179) built in 1912 between Schroon Lake and North Hudson; in 6 miles of road between Upper Jay and Keene (No. 5236), which was apparently built without expansion joints; and in the condition of the 1912 road near Java (No. 976), hardly enough of which remains to show that the road was built of concrete. The latter road was abandoned by the contractor prior to its completion and never accepted by the state. These roads are only interesting as danger signals and as additional evidence that good concrete roads cannot be built with lean concrete mixtures.

The desirability, if not the absolute necessity, for side support for bituminous roads has long been known. This is shown in the breaking down of the edges of curbless roads and has necessitated extensive repairs on many roads which, otherwise, have required no maintenance. A concrete header has many advocates, but is objectionable to the extent that it makes a sharp line of division between the road surface and the softer shoulder. Earth shoulders usually drop 2 in. or more below the surface of the header within a very short time after they are built. A better practice, which appears to be the rule in the Borough of Queens, New York City, is to use old stone for building out the shoulders a distance of about 18 in. This stone is penetrated with asphalt, and not only provides side support but makes it easy for vehicles to turn out without damaging the edge of the road surface—or the vehicle. Such a shoulder follows the contour of the road and carries surface drainage well away from the road proper. In these respects it is better than a simple concrete header and costs less.

Criticism Is Answered

By H. ELTINGE BREED

First Deputy Commissioner, New York State Highway Department, Albany

I am glad of the opportunity to reply here to the interesting "Notes on New York Road Conditions" because your paper not only has an established reputation for fairness, but also a strong influence in promulgating better highway work.

It is very true that many of our roads broke up last spring and that the repairs of these breaks were made with telford or a sub-base and drainage. The criticism of these break-ups says that all of this work should have been done before the improved road was built. That is true and that is just what this department is trying its utmost to do with every highway under construction now. But it must be remembered in respect to the old roads that the conditions of traffic under which they were built have been revolutionized by the advent of the motor and the motor truck. Roads built even as late as five years ago were calculated to endure far less strain than is being thrust upon them to-day.

Vehicle Weights Increase

This department as a department built its first roads in 1899. All of the earlier roads from that time on until about 1905 were built in the main for corresponding traffic. They were almost wholly of the gravel and waterbound types, 6 in. in thickness. During the six years there was built 519 miles of these two types and only 53 miles of brick pavement. These roads were built for existing loads of from 1 to 3 tons. To-day in many cases they carry loads of from 10 to 16 tons, and in some cases more than that. Is it any wonder that they should break up?

In design these roads were either two 3-in. courses of waterbound macadam or a 2-in. top with 4-in. bottom course. Where soft spots were encountered the poor material was removed and gravel or broken stone placed. This was customary until about 1908, when the total depth of our roads was increased from 6 to 9 in. Since then it has been increased in many cases to 12 in. in depth.

Moreover, wherever any soft spots have developed there is additional sub-base placed which forms an additional depth and gives foundation for the unstable soil. At the same time drainage is provided as a matter of economy. It was considerably cheaper occasionally to fix a small break-up by maintenance and repair than to provide extra stone the whole length of the pavement.

As an evidence of the consideration that the department is showing now in the design of its new roads, especially where they involve unusual conditions, I might cite Road No. 580 from Fancher to Brockville. This road feeds a Medina block quarry for which the shipping point is Fancher. The excessive hauling passes over about ¾ mile of this road from the railroad station to a point opposite the quarry, and this section has been constructed as Medina block pavement on concrete foundation, while the remainder of the road, 2.12 miles in length, which has lighter traffic, is being designed as bituminous macadam. This is only one of many such roads that are being built in New York State to-day.

Flat Roads

I partly agree with the writer of the foregoing article that flat roads are good. It is true that the flat crown roads encourage the spreading of traffic more uniformly over the surface of the pavement and consequently there is less wear. This department is using as crown for its roads ¼ in. to the foot on concrete, brick and pavements of the Topeka type; in general ⅜ in. to the foot on bituminous macadam, ½ in. to the foot on roads of the waterbound type and on gravel roads about ¾ in. to the foot. These crowns represent the average of conditions that we have and seem to give the best results.

In regard to the side support for bituminous roads, I might say that the suggestion of using stone block would be very costly on our state roads on account of the lack of supply of this material and the long hauls plus freight charges. While presumably the suggestion would make good practice in localities where plenty of stone blocks are available and where there is a great deal of turning out of traffic in such manner that it rapidly tears away the edge of the pavements, from what I have observed throughout the state of New York it scarcely seems as though the amount of repairs necessary to bring back the shoulders that are worn away is great enough to warrant such a very costly type of original construction. In all cases where it has seemed good economy we have provided stone shoulders to come next to the bituminous pavement. For the Topeka mix pavements that we have laid I will say that we have in practically every case provided them with a concrete edging. We have used stone-block pavement set in mortar for shoulder protection against flood since 1911. On sections of road that are subject to wash on shoulder we have provided stone paving from the edge of the pavement to the outside of the ditch. To-day we are constructing concrete block pavement on the shoulders and slopes of roads affected by flood water overflow.

Second-Class Concrete

In regard to this type of pavement very little needs to be said. These roads were built a few years ago of a 1:2½:5 mix and a 1:3:6 mix of stone in some cases, and in many other cases of gravel and run-of-bank gravel, which, with the use of average sand, gave results which in some cases have gone to pieces. However, of the large amount of this type of road built at that time some has since been repaired and covered with bituminous top, making to-day a very satisfactory pavement to ride over. The department has not, to my knowledge, built any of this type of pavement for the last two years, and it is now building only the cement concrete pavements of the 1:1½:3 mix, which needs no apologies.

I heartily agree with the writer of these comments that good concrete roads cannot be built with lean concrete mixtures, nor can they be built with poor fine or coarse aggregate. Good sand is just as essential in this type of construction as good cement, and this department to-day is taking every means possible to assure it of getting good results. We not only test all materials before they go into a pavement, but we test the mixture of the concrete as laid, 6-in. cubes being taken from batches at intervals and sent to our laboratory, where they are tested at the end of 28 days. Our requirement is for 3000-lb. compression test per square inch of surface, allowance being made for work done in the fall, and if the sample does not show this, we immediately look for the trouble. To-day we have 185.21 miles of finished and accepted concrete pavement of the 1:1½:3 mix, as well as 306.25 miles of this type under contract, and for service and durability they compare favorably with the best pavements in New York and other states.

By F. W. SARR

Second Deputy Commissioner, New York State Highway Department, Albany

Referring to the comments on the practice of this department in the construction and maintenance of improved highways as expressed in the memorandum furnished by the Engineering Record, I desire to take exception to some of the statements contained therein, particularly to those pertaining to surface treatment of macadam pavements:

SURFACE TREATMENTS

The question of the amount of cover material to be used in connection with the treatment of macadam surfaces with light asphaltic oil or tar is a debatable one. The experience of this department has demonstrated that the best results are obtained where a minimum amount of cover material is used, particularly in the treatment of bituminous macadam pavements or waterbound macadam pavements which have been previously treated and have a close or tight surface. This contention is based on the theory that the function of a surface treatment of a bituminous macadam pavement or a waterbound macadam pavement, which has more or less of a mat on the surface formed by previous treatments, is to flux and give new life to the old bituminous material in the immediate surface of the pavement. It is not the function of a surface treatment to build up any appreciable thickness of mat under these conditions. This result being desired, a minimum amount of cover material is applied to the treatment in order to allow the new bituminous material to perform its function instead of being immediately blotted up into a heavy application of cover material.

PRIMARY FUNCTION OF SURFACE TREATMENT

The primary function of a surface treatment is to preserve the immediate surface of a pavement and not to build up additional thickness. In preserving a surface a bituminous material must withstand not only the disintegrating effect of the high speed traffic but also the abrasion of the slow moving iron-tired traffic. In the first instance it acts as a cement in bonding the fragments of crushed rock in the immediate surface of the pavement together with such cover material as is applied in conjunction with the treatment, and it is well known among users of Portland cement that the strength of the mortar is diminished as the amount of sand is increased. The same reasoning holds true in so far as the cementing qualities of the bituminous cement are concerned.

Under ordinary conditions the loose sand contains about 35 per cent of voids, which may be reduced to perhaps 20 per cent by compression. The average rate of application of a surface with cold material is about ¼ gal. per square yard. At this rate about 11½ cu. yd. of bituminous material are applied per mile of macadam pavement 16 ft. in width, which is covered with from 30 to 50 cu. yd. of sand or fine crushed stone.

BITUMINOUS MATERIAL ONLY SMALL PART

It is seen therefore that the bituminous material is only from 20 to 35 per cent of the loose aggregate of the cover material, which provides very little over the amount required to fill the voids in the cover material, not considering the amount of light volatile oils contained in cold application material which soon evaporates, and the amount that penetrates the old surface of the pavement.

In the use of Portland cement with sand for concrete purposes the practice is to provide cement equivalent to from 33 to 50 per cent of the loose sand, or about one and one-half times as much cement as compared with the sand the department uses in combining bituminous cement with sand for surface treatment of macadam pavements, notwithstanding the aforesaid loss by evaporation and penetration.

QUALITY OF SAND COVER

In connection with the use of sand for cover containing a percentage of loam or clay, it is not contended that the results obtained by the use of such sand are equal to those obtained where clean, coarse, sharp sand is used. The use of sand containing a percentage of loam or clay is simply a question of economy. It is a fair estimate to state that not more than 10 per cent of the improved highways of this state have, within 5 miles of the highway, local pits from which clean, coarse sand may be obtained. It is then a question of importing selected material or using the best local material that the community will provide. While I prefer a clean, coarse sand for cover, still, considering the results we have obtained from sand containing a percentage of loam, I am inclined to believe that the importance of the grade and quality of the material used for cover is overestimated.

It is stated in the comments that the conclusion must be drawn that quite different treatments should be applied to bituminous macadam pavements than to the waterbound type, and two highways are specifically mentioned as examples of bituminous macadam pavements which have been injured by treatments of light oil. I have driven over both of these roads two or more times during the past season and did not observe the mushy or rutted condition of the surface to which the comments refer. The statements in regard to the treatment of the roads are erroneous, and such errors would tend to discredit the statements in regard to the condition of the pavements.

CONDITION OF OIL-TREATED ROADS

It is stated that on the Ballston Road (No. 5062) the portion outside the village was given a surface treatment and the portion inside the village was not treated, and that the latter portion, which was not treated, was in much better condition than the portion of the pavement outside the village which had been given a surface treatment. The records of the department indicate that no portion of this road had been given a surface treatment until July of the present year, when the entire length of the pavement, both inside and outside the village, was given a light treatment of light oil. It is therefore evident that, provided there is any difference between the section of pavement within the village and the section without, this difference must be the result of something other than surface treatments, as both sections at all times have been in the same identical condition so far as surface treatments are concerned.

The statements in connection with Road No. 672—Columbia County—are to the effect that a surface treatment of "light oil has resulted in mushing up the surface of the road, notwithstanding which a contract for reoiling with light cold oil has been let." The records indicate that Road No. 672 is something over 6 miles in length and that in 1915 about 3 miles, or one-half the length of the road, was given a treatment with light cold oil, and this year, after observing the effects of the first treatment, the division engineer recommended the same treatment for the other half or remainder of the road. It does not appear credible that after treating one-half the length of a road and observing the effects of the treatment for a year, and providing it was apparent the treatment had been injurious to the surface, the remainder of the road would be given the same identical treatment.

The comment also states that where seal coating had been carried out with heavy asphaltic cements the results are uniformly much better than those obtained with the lighter materials. This statement is purely a theory and surely not the result of the observation of the maintenance of the New York State improved highways, for the obvious reason that only few seal coats or light surface treatments with heavy asphaltic binder have been given as a maintenance proposition to New York improved macadam highways, and none of those so treated have, to my knowledge, proved a success. Some heavy surface treatments with binder have been given to old macadam pavements for the purpose of building up and truing up the old surface by increasing the depth approximately 1 in. This treatment could not, however, be termed "seal coating," but rather a light resurfacing by the penetration method, where stone of ¾-in. size is used as the aggregate, which is rolled and consolidated with a steam roller in the manner of penetration macadam construction. The cost of such heavy treatments is at least four times as much as that of the light cold oils, and they are employed only to restore a surface which shows material deterioration and are only a makeshift for regular resurfacing necessitated by lack of funds and are not recommended.

It is therefore evident that the comments referred to are not based on a close observation of the results of the maintenance work in this state, and I do not believe, as a whole, they should be taken very seriously.

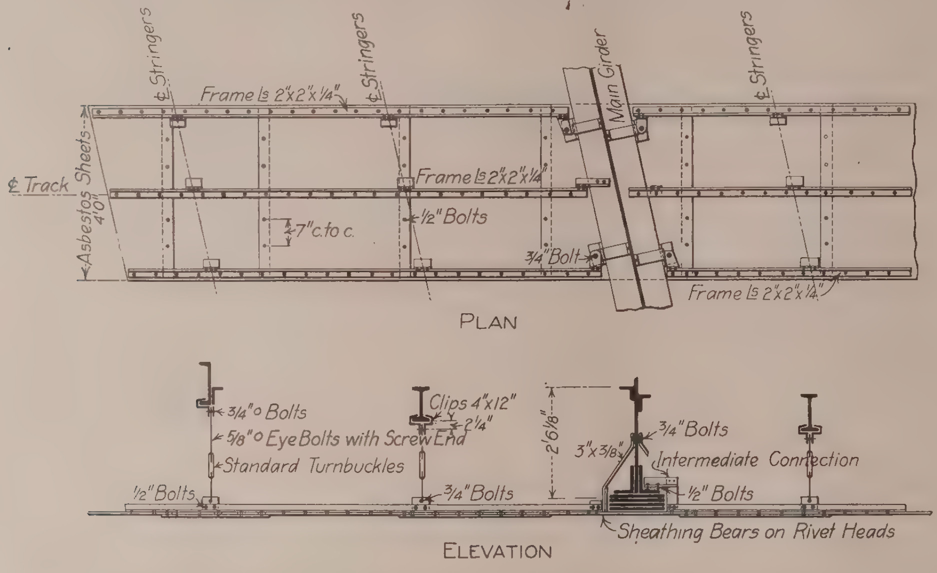
Road Maintenance Men Scarce

Few men are experienced in the maintenance of various types of roads, according to a statement by B. H. Piepmeier, maintenance engineer, Illinois State Highway Department, in the October issue of *Illinois Highways*. There seems to be a tendency to shun this phase of road work in preference for construction. The fussy methods necessary do not appeal to them. Again, the usual plan for making repairs on a road is to wait until it becomes almost impassable and then hurriedly secure the services of the first man available for doing the work, with very little thought as to his experience. A good maintenance or repair man cannot be trained in a day or one season, nor can a road be effectively maintained by only occasional consideration. Effective and efficient maintenance is accomplished only by constant attention of the experienced man that will give personal attention to all details of the work. It is the utter neglect of maintenance and improper methods followed by many road officials that have molded the sentiment of the masses of people against such work. The neglect of maintenance has not only served to destroy many useful and economical roads, but in many cases has molded sentiment to have no faith in any type of road that requires annual maintenance. This neglect and inefficiency on the part of many road officials have led road promoters to disregard the type of road which in many cases would be most economical for a community.

Asbestos Sheathing Protects Steel Overhead Bridge

Bolted Frame Hung from Under Side of Floor Above Center Line of Tracks Supports Asbestos Sheets

AFTER more than a year's service a relatively simple form of protection for the under side of the Whitehall Street bridge over the Western & Atlantic Railroad tracks in Atlanta, Ga., has proved to be completely satisfactory in preventing the loss of metal due to the cutting action of the locomotive blasts. It is claimed by the engineer who designed the asbestos sheathing and steel frame here shown that the principal cause of loss of metal in such overhead bridges is the blast, rather than corrosion or effect of gas. This claim appears to be substantiated by the fact that although the protecting shields extend only 2 ft. on each side of the center of each track under the bridge and the smoke and gases have access to the metal, no evidence of any further loss of section has been found.



FRAME SUSPENDED FROM BRIDGE STEEL SUPPORTS ASBESTOS SHEATHING

Frames 4 ft. wide over the center lines of each of the eight tracks running beneath the bridge are supported from the stringers or the main girders by clips and adjustable hangers, as shown in the drawing. Clip angles are bolted to the frame angles, and eyebolts connect to them, as noted, by ¾-in. bolts. At the main girder two types of support are used. The intermediate connection is a 2 x 2 x ¼-in. angle embedded in a 1:2 Portland cement mortar on top of the lower flanges of the girder; the outer connections are bent straps bolted to the web of the girder as shown.

The asbestos sheathing was obtained in standard 4 x 4-ft. sheets ⅜ in. thick. Instead of using brass bolts as first planned for all cases of exposed heads below the sheets, a satisfactory protection was obtained by using a 1:3 Portland cement mortar and asbestos fiber, placed as a hemispherical covering over the bolt heads by using a cup-shaped form in a small block. The bolt protection has remained intact.

This design is the result of considerable study by C. E. Kauffmann, engineer of bridges, Department of Construction, city of Atlanta. The asbestos sheathing was furnished by the Keasbey & Mattison Company, Ambler, Pa.

Recommend Isolated Sewage-Treatment Plants for Lake Cities North of Chicago

Messrs. Alvord, Eddy and Fuller Advise North Shore Sanitary District Trustees to Empty Chlorinated Effluent from Imhoff Tanks Into Lake

TO discharge the chlorinated effluent from Imhoff tanks into Lake Michigan opposite each separate municipality is the advice given to the North Shore Sanitary District trustees having in charge the disposal of sewage of 36,000 people living in a 20-mile strip 1¼ to 3 miles wide bordering on Lake Michigan in Lake County, Illinois. Seventeen different projects were studied by the board of consulting engineers, John W. Alvord, Harrison P. Eddy and George W. Fuller, after the collection of preliminary data for the trustees by Langdon Pearse and S. A. Greeley. The trustees, headed by W. J. Allen, chief engineer of the Waukegan waterworks, have recently published the report from which are taken the following basic data as to size and capacity of treatment plants and reasons for adopting the scheme:

PROVISION FOR FUTURE

Structures such as collecting sewers, force mains and pumping-station buildings, which cannot economically be enlarged to meet the increased demand of a growing community, have been estimated to provide for a maximum of 400 gal. of sewage for each person assumed to be connected with the sewers in 1950.

Sewage treatment works can be built in units with additions added later as required, and hence the present estimates of cost are applied to structures of a size to meet the needs of the 1930 population.

Although the pumping-station buildings will be designed of a size sufficient to accommodate the machinery required to pump the 1950 maximum rate of flow, only such portion of the machinery will be installed at the outset as will be required to meet the maximum 1925 rate.

MAIN FEATURES

Grit Chambers—For the Waukegan sewage from combined sewers, grit chambers will be provided to give a flow for a distance of about 60 ft. in a series of tanks in which the velocity of flow is from 8 to 12 in. per second.

Imhoff Tanks—The sedimentation compartment is taken as equivalent to 3.33 and 2.22 cu. ft. per capita for the flow of combined and separate sewers respectively. This will provide two hours' sedimentation for an average flow of 300 gal. in 25 hr. per capita, or 3 hr. sedimentation for an average flow of 200 gal. per capita in the case of combined sewers. With separate sewers there will be a 2-hr. sedimentation period at the flow of 200 gal. per 24 hr.

The piping connections and "freeboard" of the tank would be arranged so that if desired at the beginning of storms as much as 900 gal. per capita of storm flow of combined sewers could be passed through the tanks.

CAPACITY OF SLUDGE-DIGESTION TANKS

The capacity of the sludge-digestion tanks has been estimated in accordance with Dr. Imhoff's advices, as follows: For small plants treating the flow of separate sewers and with a population of less than 5000 people, the digestion chamber is taken as 2.4 cu. ft. per capita. For materially larger plants to treat the flow of separate sewers, the volume may be reduced progressively to 1.2 cu. ft. per capita. For combined sewers in large cities like Waukegan digestion chambers are taken as having a capacity of 1.8 cu. ft. per capita.

For sludge-drying beds an area has been provided for the flow of separate sewers equal to 1/3 sq. ft. per capita, with an increase of 50 per cent in the case of the flow of combined sewers.

Trickling Filters—These have been figured on the basis of an effective depth of 6 ft. with a load factor taken as 20,000 people per acre in the case of the flow of separate sewers and 12,500 persons per acre in the case of combined sewers.

Contact Beds—Estimates have been prepared on the basis of treating the settled sewage flow from 2500 persons for each acre of contact bed of a depth of 4 ft.

Sand Filters—Estimates are prepared on the basis of treating the settled sewage flow of 1000 people per acre of filter surface with beds averaging 30 in. deep.

Chlorination—The estimates provide for automatic devices in duplicate, whereby with the aid of a weir chlorine would be applied to settled sewage and to all storm overflow in quantities as required up to about 100 lb. per 1,000,000 gal.

3-HOUR MINIMUM AËRATION PERIODS

Activated-Sludge Process—For the activated-sludge process estimates have been prepared on the basis of a minimum period of aëration of 3 hours at the maximum rate of sewage flow. For the aërating tanks, having an assumed depth of 15 ft., air is figured at the rate of 1 2/3 cu. ft. per gallon of sewage treated. The plans include also a sedimentation tank providing 1 hour's sedimentation at the maximum rate of sewage flow; a sludge-storage tank holding ten days' output of sludge; and sludge-drying facilities consisting of either sludge-drying beds of an area ten times as great as that for the Imhoff tanks or else presses to treat from 0.75 to 1 ton of dry solid sludge per 1,000,000 gal. of sewage taken as of a strength of 100 gal. per capita.

Costs of Operation—It was estimated in the various projects that a central office and laboratory would cost about $4,500 per year. This sum would include the services of a superintendent and also a chemist and bacteriologist, with allowances for an automobile and various laboratory and general supplies. In the estimates of cost of construction there is an item of $15,000 allowed for a central office and laboratory building.

ALLOWANCE FOR LIQUID CHLORINE

The allowance made for liquid chlorine is on the basis of 17 cents per capita per annum, equivalent to a dose of 30 lb. per 1,000,000 gal., with chlorine at 10 cents per pound, and with the sewage assumed to be of average strength of 150 gal. per capita daily in all projects except activated sludge, dealing with the treatment of sewage on the lake shore. A further allowance for the chlorination of storm overflows has been made and taken as equivalent to 20 per cent of the cost of chlorinating the ordinary dry-weather sewage flow.

The cost of pumping is estimated on the basis of using electric current at prices quoted by the local electric company and ranges, for different-sized pumping stations, from about 1 1/3 cents to 3¾ cents per kilowatt-hour. The cost of power for aërating sewage in the activated-sludge process has been arbitrarily taken at 1 cent per kilowatt-hour at Waukegan and 2.3 cents at the other stations.

The project selected would eliminate as far as possible long and expensive collecting systems of sewers, pumping stations and other radical extensions of the present local sewer system. It would introduce new sewage-disposal plants for populations not now provided with sewage treatment, improve the plants now existing, which appear to need improvement, and properly enlarge and much better operate existing plants which appear to be of good design and of reasonable capacity.

ADVANTAGES AND DISADVANTAGES

The plan suggested can be put in operation more rapidly than any other project herein considered. It will cost less for construction and operation than any other project. It proceeds along lines in which the engineers have had large experience and which they feel certain will be successful. Under a continuing policy in systematic skilled supervision, such as is possible under the management of one board, it can be made to give satisfactory results, while under separate ownership and lack of skilled supervision and technical control it has heretofore failed. It requires less length of intercepting sewer, disruption of pavements and general upheaval of existing conditions than any other project. It has the advantage of utilizing the natural oxidizing agencies of the lake water for the final stage of purification.

Against these items are the disadvantages, as follows: The mere presence of a sewage-treatment plant, even if operated so as to be inoffensive, prevents many persons from indulging in the full enjoyment of the most attractive beauty of the lake shore. The plants are necessarily located at the mouths of the ravines, points where the public has most occasion to have access to the lake. Some of the plants are, and will be, unfortunately, near the small lake-shore parks and bathing beaches. If in the future the policy of the Sanitary District trustees should become so penurious as to restrict operating expenditures improperly, rely on untrained supervision and abandon necessary care, then the plants will become offensive and dangerous again, as is now the case. With lack of attention, as cited, and growing population, the plants, if abandoned as to care, are likely to allow the sewage so to pollute the lake as to become a menace to the water supplies of the various municipalities, even if filtered. The presence of handsome estates and beautiful homes in the immediate vicinity of the plants will always necessitate much more careful and skillful operation than is required at many sewage-treatment plants more favorably located.

Nevertheless, the engineers held that they could see no reason why this project, with proper engineering design, suitable technical supervision and adequate expenditures for maintenance as estimated, could not be made quite unobjectionable from every point of view, and, with adequate filtration of the domestic water supply, entirely safe from a sanitary standpoint. This project is also the cheapest, the estimated cost being $477,470 for sedimentation and chlorination works, and the annual cost will be $37,900. Exclusive of collecting sewers, pumping stations and land, the cost is $27,780, and the yearly cost $27,780—and this for plants which would remove practically all solid matters which would settle out in water and from 90 to 95 per cent of the bacteria in the sewage and in all storm flows. Outlet pipes extended into deep water would remove all questions of nuisances at the beaches, and no odor should be noticeable from 100 to 200 ft. from the plants.

ACTIVATED SLUDGE TOO EXPENSIVE

The activated-sludge treatment would cost something less for investment than

Before and After Building Soil Roads in Two Virginia Counties

THE effect of road improvements in Brunswick and Lunenburg counties, Virginia, is indicated by the photographs. The views on the left show conditions as they were; those on the right picturize the condition of the same two spots after improvements had been effected. In Lunenburg County 45 miles of top-soil road was built by convict labor at $800 a mile, 60 miles at a unit cost of $1,000, and 40 miles was contracted for at $1,250 a mile. The roads were graded for a width of 24 ft., with 20 ft. of resurfacing 10 in. deep at the center. In Brunswick County most of the work was on the old Petersburg-Boydton plank road, built in 1850. No repairs were made recently. Not long ago a stretch of 24 miles was improved at a cost of $1,000 a mile, as shown in the lower views. G. P. Coleman, state highway commissioner, furnished the pictures and data.

would sedimentation tanks and chlorination, but the operating cost under the unusual local conditions becomes so much in excess of that chosen that the engineers felt constrained on present evidence to advise against its adoption.

The advantages of the activated-sludge method over Imhoff tanks and chlorination are that it would remove more of the organic impurities and produce a clear, nonputrescible effluent, which would need no chlorination. It is also probable that there would be less likelihood of odor around an activated-sludge plant than near Imhoff tanks, although not much significance was attached to this point in either case.

The single disadvantage to this process seems to be in its excessive cost under local conditions, where the amount of air applied appears to be very high for this exceedingly dilute sewage because of the necessity of applying sufficient air thoroughly to mix the activated sludge with the sewage for a period of at least three or four hours. Furthermore, under local conditions the amount and cost of power due to pumping and aërating are greater than they would be for large central plants, as figured for Milwaukee or elsewhere. This is true of the scattered plants required on the southern end of the district, where it is necessary to provide several treatment plants or else to go to quite heavy expense for collecting sewers. On the question of sludge disposal, the evidence is not complete and therefore the engineers feel obliged to use estimates of cost based on experience at Worcester in pressing the sludge, with the figures expressed in tons of dry solids.

The final statement is that there is no advantage to offset the added total cost of the activated-sludge treatment in comparison with sedimentation and chlorination.

INTERIOR VIEW OF FINISHED FLOOR SHOWS DUCT OPENINGS IN COLUMNS

Hollow Columns and Roof Ducts to Ventilate Concrete Building—Floors Waterproofed

New Cluett, Peabody & Company's Factory at Troy Designed to Provide Floor Drainage and to Eliminate Dust by Ventilation System

ANOTHER example of the use of hollow columns of reinforced concrete (see the Engineering Record of Nov. 18, page 620) is Cluett, Peabody & Company's new building at Troy, N. Y., now in course of construction. Instead of cast-iron duct outlets, the columns are cast with the desired curved openings near the ceiling and additional steel reinforcement is placed around these openings. Another unusual feature of this structure is the waterproofing of parts of the two upper floors to provide drainage facilities where collars are starched after washing. Double-glazed windows are furnished in order better to insulate the building.

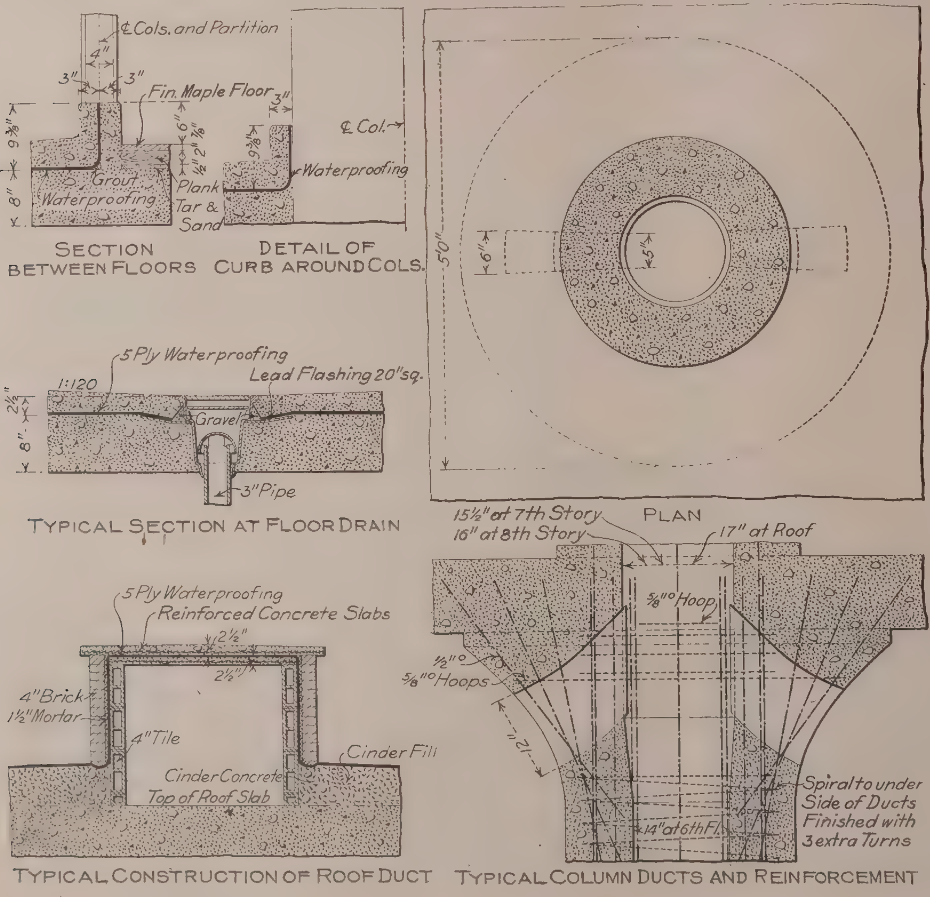
The new main manufacturing building is eight stories high, with basement, adjoining the present six-story building on the north. The plan consists of a rectangular portion 100 x 175 ft., with a projecting wing on the south side two bays wide and over five bays long. The bays are nearly equal in the two directions, forming floor slabs 20 x 22 ft. in size. The building is located at the intersection of Hutton Street and the Hudson River. As the street slopes downward toward the river on a steep grade, a retaining wall for the earth backfill was necessary. This was designed as a vertical 12-in. slab between the floors, using ¾-in. vertical reinforcing rods on 6-in. centers, with ½-in. temperature rods placed horizontally above the grade line on the outside. The basement, in which is stored coal for winter use, is often flooded when the river rises.

The typical floor slab is 8 in. thick, reinforced by ½-in. rods in two directions. Upon the rough slab is placed a leveling coat of tar (Tar Rok) ½ in. thick, then a 2-in. layer of spruce plank faced one side and the wearing surface of ⅞-in. matched maple flooring, after treating the plank underflooring with creosote oil. The two lower floors were designed for 150 lb. per square foot live load, and the upper floor for 100 lb. At heavy machines the slab was increased to 10½ in. thickness and reinforcement added.

FLOORS WATERPROOFED

Parts of the seventh and eighth floors are waterproofed by 5-ply felt and pitch, with special curb details at edges and around columns, as shown in one of the drawings. Floor drains, one in each panel, are central in one direction and about 6 ft. from the line between columns in the other direction. Tests of these floors showed absolutely watertight construction.

As the part of the building first completed contains no elevators, it was decided to furnish temporary service by constructing a shaft of timber framing on the outside, covered with galvanized iron on wooden sheathing. This frame is indicated



TYPICAL COLUMN AND ROOF DUCTS AND DETAILS OF WATERPROOFED FLOORS

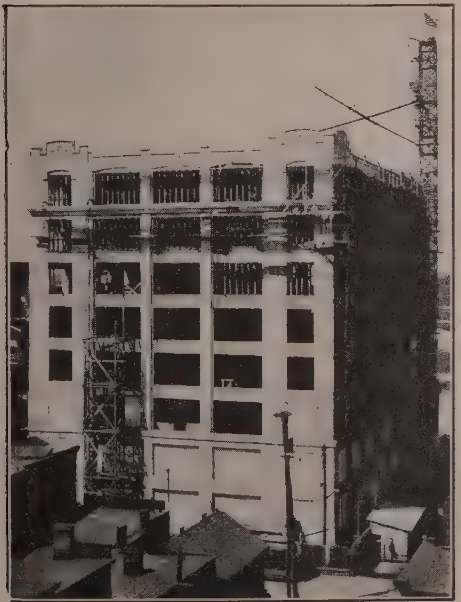
ROOF DUCTS UNDER CONSTRUCTION

in one of the photographs. A sprinkler system of the dry-pipe type is installed, as shown in the photograph of the interior.

The main columns are hollow, reinforced by vertical rods and outer spiral steel, with the spirals stopping at the duct outlets, as indicated on one of the drawings. Special rod reinforcement is provided around these openings, which are formed by the use of properly shaped curved boxes inserted before placing the concrete in the column forms. The forms were of steel inside and outside, the inner form remaining permanently in place as a duct lining. A blower system of ventilation is used, the column ducts being connected at the roof to roof ducts which converge in the pent house on the wing where the fans are located. Details of these roof ducts, which are carefully waterproofed, are shown.

As it is essential in a factory of this kind to exclude all dust, not only washed air for the ventilating system but double-glazed windows have been used. On the outside ¼-in. ribbed wire glass and in the inside ⅛-in. ribbed glass are used in the steel sash (Lupton type).

The building was designed and constructed by Westinghouse Church Kerr and Company, engineers and constructors, New York City. H. H. Forsyth was engineer in charge and D. Tattrie was superintendent of construction.



OUTSIDE ELEVATOR FRAME FOR TEMPORARY USE BEING ERECTED ON LEFT

What the Development of Foreign Trade Means to the Engineer

Expansion of His Field Depends on Investment Abroad—Progress to Date Has Been Small—Lack of Trained Men Serious Handicap

By F. LAVIS
Engineer, American International Corporation, New York

THE ANALYSIS of the present industrial situation in this country as set forth in Mr. McGraw's address (Engineering Record, Nov. 4, 1916, page 554) is most timely. It seems extremely important that engineers especially should realize what the conditions are, as on a correct solution of the problems confronting us, and especially on the possibilities of extending our activities into foreign fields, depends a great deal of their future.

Engineers are coming to realize more and more the necessity of co-ordinating their technical knowledge with a reasonable knowledge of both financial and commercial conditions, and in view of the great possibilities of extraordinary changes in the general financial and commercial situation in the near future—that is, within the next two to five years—it seems not inappropriate to emphasize further some of the features of Mr. McGraw's address and also to extend the argument somewhat.

PRESENT PROSPEROUS CONDITIONS

Our manufacturing plants are running at full blast and their capacity is increasing at a really tremendous rate. One large engineering firm of which the writer has knowledge has 250 draftsmen employed and contracts for work totaling $20,000,000, nearly all for manufacturing plants; and this seems to be typical of general conditions all over the country, or at least in the manufacturing areas, and these latter are being rapidly extended. Our crops are good, prices are high and money is plentiful—in fact, too plentiful, as credits are tending to become too much inflated.

The writer knows personally of one manufacturing concern with a nominal capital of $100,000 doing a business this year of nearly $3,000,000 gross, which requires a cash capital of $500,000, all of which is obtained with the greatest facility from the banks, which latter indeed even almost urge larger borrowing.

BASIS OF CREDIT

A quotation of $43,000 was made a few weeks ago for a locomotive that two years ago could have been bought for $23,000. Wages are all high, they are getting higher, the cost of living is increasing and we are building a beautiful pyramid which is a most stable structure as long as its base is solid. Our financial pyramid of credit is, however, based on our gold reserve; that is, on our stock of gold.

Frank A. Vanderlip likened our credit system and the gold reserve on which it is based to a cone of sand piled on a dime. If we increase the dime to a quarter and maintain the same ratio of height to base the volume of the cone is increased in a much greater proportion than the increase in the base.

Our present large possibilities of credit based on existing large holdings of gold will therefore be a most serious menace to the stability of our industrial structure if the base is appreciably diminished, as it will be if and when conditions cause the flow of gold to be turned back toward the European countries.

It is because of this that some of our leading financial interests, leading because they are farsighted, believe that we must encourage foreign trade in order that we may pay for our future requirements of foreign-produced goods and raw materials with materials rather than with our present store of gold.

EXCESSIVE MANUFACTURING CAPACITY

Before the war, say in 1913-14, it was estimated roughly, as I remember the figures, that our manufacturing capacity was some 25 or 30 per cent greater than our normal domestic needs, plus what little foreign trade we then had. With the present increase in manufacturing plants, even allowing for the scrapping of many of them of more or less temporary character, but realizing that the increase is likely to continue for another year and quite likely two years, we shall find ourselves by the time Europe begins to take hold again after the war, and it will not be very long after, with a manufacturing capacity two or even possibly three times as great as we need for our domestic needs.

If our foreign trade has not then developed and been placed on a sound basis we shall be faced with a very greatly lessened demand, a curtailment of credit, a generally lessened wage scale, a consequently lessened domestic consumption; in fact, unless the wisest counsels prevail in the meantime, an economic crisis.

EFFECT OF TARIFF WALL

We may possibly build a tariff wall high enough to keep out foreign staple manufactured goods, but this can be only a temporary makeshift, and we shall die of dry rot from attempting to live within ourselves. There is the most urgent need today for industrial preparedness which will permit us to fight and win the battles for the foreign markets which will be most intensely fought after the war and which we must win if we are to retain any commanding place in the markets of the world.

It is assumed to be impossible to lower the scale of wages in this country, and therefore it seems to many that we must use a high protective tariff and keep out the lower-priced goods of Europe. On the other hand, however, if we do that we keep up our high wages and thus shut ourselves out from foreign markets. A tariff which is too low means foreign competition in our domestic markets. There is undoubtedly a happy medium, but it will require something better than muddling to strike just the right mean with the tariff to keep our wage scale up to the highest reasonable level and yet permit competition in foreign markets. Experience has shown that with a wage scale quite a little higher than that of Europe we can still compete. It is entirely probable that the cost of production in Europe will be increased to some extent, but it seems improbable that we can compete and maintain our present scale of wages.

In spite of all the talk soon after the war started that we were in a position to capture a large part of the trade in the foreign markets of the world, we have made comparatively little progress. Our trade has increased, of course, because the production of Europe has been greatly reduced, but foreign nations have been buying only American goods which they needed so badly that they had to have them, and which they could not obtain elsewhere. This, however, is hardly a firm basis for an established foreign trade.

FOREIGN INVESTMENT

It is a *sine qua non* that our foreign trade will be firmly established only when backed up by the investment of our capital in the countries which need it for their development. Up to the present time the United States, England, France, Germany and Belgium have been the great manufacturing countries which have supplied manufactured products, particularly those of steel and the textiles, to the world. Incidentally, they have also supplied the capital for the development of these other countries which produce foods and raw materials in excess of their own needs. The people of these latter countries usually lack the capital and the natural inclination to exploit successfully the transportation systems on which their development depends, so that foreign capital and foreigners are required for the development of railways, general public utilities, water powers, sanitation, lighting, mines, etc., leaving the people of the country free to develop their own natural pastoral and agricultural resources.

It is in this development of transportation, etc., that American engineers hope to have a share. It has been previously noted that far-sighted American financiers and business men have realized the necessity for our entrance into the field of foreign investment of our capital, not only because it is solely by this means that we can obtain a firm hold on foreign markets and create a continuous demand for our manufactured products, but also because if we can make these investments safely and with the assurance of reasonable profit we have an additional means of maintaining our financial position with the leading nations of the world.

AN ILLUSTRATION

The following may be cited as a fairly typical illustration of the financial operation, taking an actual case.

A certain railroad which it is proposed to build in South America is estimated to cost $7,000,000. Of this not more than $3,000,000 will be spent for labor in the country, of which $2,000,000 will be returnable as subsidiary in bonds payable within, say, 10 to 20 years; that is, for an outlay of $1,000,000 in cash (gold) outside of this country we acquire a $7,000,000 investment abroad. We contribute steel rails, steel bridges, locomotives, cars, etc., our trained engineers and administrative skill and ability, but these are materials we produce ourselves. They are valuable, but they are not money, and if we retain the money we retain by that much the base of our pyramid. This is our credit, and therefore the ability to produce more goods. If we let England or France do this work and lend them the money with which to do it we reduce the base of our pyramid by $7,000,000 instead of $1,000,000. In addition we sacrifice the future market and possible foreign friends.

It seems very evident therefore that we should make foreign investments, and offhand it seems very simple. In actual practice, however, it is rather more difficult than it appears on the surface. There are two reasons for this: First, we can get a higher rate of interest on our capital right here at home than foreign countries have been accustomed to pay; second, our methods of business are different from those of the European nations with which these foreign countries have been accustomed to deal; and, third, we have only a very minute proportion of our people educated either to take up foreign securities (outside of the government loans of some of the most important countries) or as foreign administrators for construction or operation.

There has been a theory that foreign securities might be held by a corporation formed for this purpose which would issue its own debenture against them. This might well be done to a certain extent, but really its possibilities are so limited that until the investing public generally participates in such investments and absorbs them there is little hope for such a development of this field as is necessary if America is to obtain a fair share of the markets.

TRAINED MEN LACKING

The difficulty in regard to training efficient administrators is also a serious one; with even our very limited demand to-day it is felt. We have the ability to make good, but we lack actual experience in the foreign field, and many men will be tried who have made good at home but will fail abroad, so that the process of building up a large class of men who have technical or business ability, knowledge of foreign languages and ability to live on terms of amity with foreigners in their own country, and who will not let the sometimes almost intolerable loneliness drive them to dissipation, is one which is going to require infinite patience.

The third reason, namely, that foreign countries have not been accustomed to pay as high a price for their money as we require now, because the price is regulated by the demand and we cannot make foreign investments at a lower rate than or even as low as we can obtain at home, is one which will adjust itself in time, but which is a very real factor to-day in preventing our rapid entrance into the foreign field. The European nations for years to come will probably not be able to supply capital as lavishly and at as low a rate as they formerly did; but mindful of the illustration previously given, we must not delude ourselves with the idea that they will not find means of holding their foreign markets by making the necessary developments, especially in view of the fact that the actual cash required to be sent out of the country is only a small proportion of the total investment.

In spite of our experience after two years of abnormal conditions due to the war there still seems to be an inadequate appreciation of the general principle governing our participation in foreign trade, and because of the importance of the subject for our future development it is hoped that engineers who should be and generally are interested in the necessary preliminary investigations and should have sensible visions of the future will help formulate and disseminate the true theories and principles which must govern it.

Bottom of Pipe Perforated for Air Distribution

Pipes in Sewage Tank of Edmonton Activated-Sludge Plant Have ⅛-Inch Holes on 3-Inch Centers in Under Side

AIR DISTRIBUTION in the sewage tank of the activated-sludge plant at Edmonton, Canada, is accomplished by pipe perforated on the under side. A. W. Haddow, acting city engineer, has supplied the following information regarding this feature of the works:

The air main along the center of the tanks has been started off at 10 in. diameter. This 10-in. main is of cast iron, as it is found to be best for tapping and making tight connections for the down pipes. The tank under experiment has four 1½ in. down pipes, with a valve, and a Dart union below the valve on each pipe. They are placed 30 in. on centers and branch into two 1-in. pipes at the bottom of the tank running toward each end, where they are plugged. Each down pipe with its two branches is an independent unit, and by unscrewing the union it can be lifted for examination without interfering with the blowing on the three other pipes. The two branches are supported from channel irons by means of six ⅜-in. hollow rods (pipe), which by means of a thread and nut give a slow-motion control of the air pipes. After the air pipes have been set dead level, it is necessary both to raise and to lower them by means of these nuts to obtain perfect air distribution. Mr. Haddow cannot give any reason for this.

⅛-INCH HOLES ON 3-INCH CENTERS

The air pipes have ⅛-in. holes drilled on the under side at 3-in. centers. This gives better distribution than drilling on the top or on the sides. So far, Mr. Haddow reports, the resulting air distribution is excellent. However, no sludge has yet accumulated.

Each down pipe is connected, below the valve and above the union, to a branch from a 3-in. high-pressure water main (100 lb. per square inch) for flushing purposes. These four water branches are controlled by a single valve. In addition, the water can be shut off by a main valve and steam admitted through the same piping. Provision is made for expansion on this account. Then, as already stated, each air line can be lifted independently and cleaned, if the water and steam are not sufficient. A check valve is introduced on the main air feed, near the blower, to prevent water getting into the blower in case of carelessness in operating the valves.

Railroad Income for July and August Continues Upward Climb

Gross operating revenues for July and August on the large steam railroads of the United States, according to bulletins issued by the Bureau of Railway Economics, were respectively $1,315 and $1,418 per mile, showing increases of 16.3 and 19.1 per cent as compared with July and August of 1915. Operating expenses were $848 and $882, increases of 13.1 and 15.4 per cent. Net operating revenue therefore was $467 and $536—increases of 22.7 and 25.8 per cent, and operating income was $411 and $476—increases of 24.7 and 27.1 per cent.

HINTS FOR THE CONTRACTOR

Details Which Save Time and Labor on Construction Work

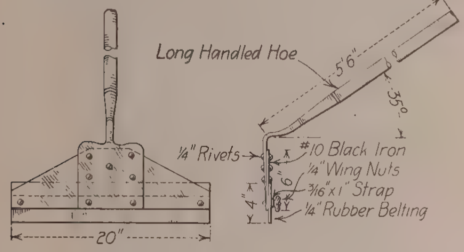
Other articles in this issue of interest to contractors and construction engineers are indexed in the Table of Contents

Contributions to this section are solicited, and if found available will be paid for. They must be SHORT, *and should be accompanied, if possible, by photographs or sketches.*

Makes Pavement Squeegee Out of Old Hoe

THE SQUEEGEE for working grout filler into granite-block paving used by the Brooklyn Rapid Transit Company of New York City is shown in the sketch. The demand for this tool in Brooklyn, where this method of laying granite-block paving is required by the borough, is such that in order to supply each track gang with one implement a large number of superannuated hoes have been cheated out of well-earned rest on the junk pile.

The device is described by R. C. Cram, assistant engineer of the way and structure department of the company referred to, in a recent issue of the *Electric Railway Journal*. The author states that the squeegee method, which has begun to displace the practice of brooming in the grout in brick pavements, has proved much superior to the latter method in constructing modern pavements of smooth-topped granite blocks in Brooklyn.



SQUEEGEE MADE FROM HOE

This Paving Contractor Works All Winter—But Not Outdoors

"I CERTAINLY envy the highway contractor in winter," remarked the editor of the *Contractor's Atlas* the other day to a friend who makes his living by constructing pavements.

"No millionaire has anything on you from December first to the ides of March. All you do is to figure out your profits for the year and run away to Palm Beach or some other summery clime to spend your ill-gotten gains. That is the life!"

"Don't you believe it," retorted the contractor, "and if you really would like to know how I spend my winters, I'll tell you."

And as this contractor's plan for making the winter profitable is one that might well be followed by many others, the editor has passed it along, and here it is in the contractor's own words:

"You know I take work anywhere within a radius of 200 miles. Beginning about the first of October, I have my stenographer start a little clipping bureau. She reads all the engineering and contracting publications, and as many daily and weekly papers as we get, and from them clips all references to city, town or county highway bond issues or plans for road or pavement construction. Then, about the middle of November, when I have cleaned up my year's work, I begin to study these clippings. About the first of December I pack my bag, not forgetting a box of good cigars, and start. When I land in a town, I make the acquaintance of everyone who has anything to do with highways—and believe me, I am a real highway booster. I go after them from every angle, and can often render real assistance.

"Maybe the town has no engineer and does not intend to hire one until they know what they are going to do. So I give them the benefit of my practical experience. Possibly the committee on streets had figured on a type of construction on which no contractor would be required, doing the work by day labor. Then I get busy and talk them into a plan where they will finally need me. And all the time I am getting acquainted with them and they with me.

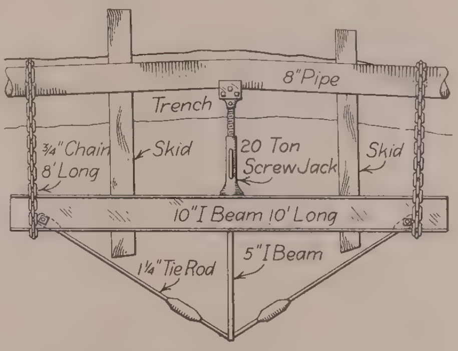
"Of course, I am home for Christmas and New Year's, but after the holidays I am away again until the middle of February. After that the seeds I have sown begin to return a harvest in the form of requests for bids on contracts. Of course, you will say that I would get many of them anyway. Right. But don't forget that by that time I know all the men who are really letting the contracts, and if they are giving out any favors or preferences in the bidding it's their old friend whose cigars they smoked in December and January who is going to get them. That's human nature. I have been doing this for several years and I find the work pays, and pays big.

"Some of my friends spend their winter months on Southern contracts, but I can't see them because you have to start work on them before your Northern jobs are done, and generally you are still working down there when you ought to be looking after new work in the North. So I stick to my natural territory and work it twelve months in the year. If you don't think it pays, ask Dunn or Bradstreet to tell you how we grow each year."

Machine Bends Eight-Inch Pipe at Low Cost in Field

THE SKETCH shows a machine in successful use by the Philadelphia & Suburban Gas Company at Chester, Pa., for bending gas mains up to 8 in. diameter in the field as they are laid. Bending the pipe cold as bends are required while laying it in the field has proved very economical with the smaller sizes, but has generally been found too expensive with pipe above 4 in. in diameter. The method of using a block and fall employed with the smaller sizes cannot be used with an 8-in. pipe in most cases, as the pull required makes it difficult to find strong enough anchorages to resist it. Even when this method can be used, it takes 25 men and costs from $3 to $6 to make a bend in this way. With the machine shown in the drawing four men can make a bend in an 8-in. pipe at a cost of from 50 cents to $2.50, depending on the radius of the bend and the total deflection that must be produced.

To operate the machine, the chains at each end are secured around the pipe and I-beam with slip links, the jack and pipe block are set in position and the jack tightened to make the bend. If only a slight deflection is required, the bend may be made with one setting of the machine. If the bend is a considerable one, the machine should be shifted along the pipe, making several bends of a few degrees each in succession until the required deflection is reached.



MACHINE COLD-BENDS HEAVY PIPE IN FIELD

Another considerable advantage of this machine over the old method is that all the bends for a pipe line may be made continuously without waiting for the actual work of laying the pipe to reach each deflection point before the bend at that place can be made.

The machine was described at the recent annual meeting of the American Gas Institute by Charles Wilde, engineer of mains for the company mentioned.

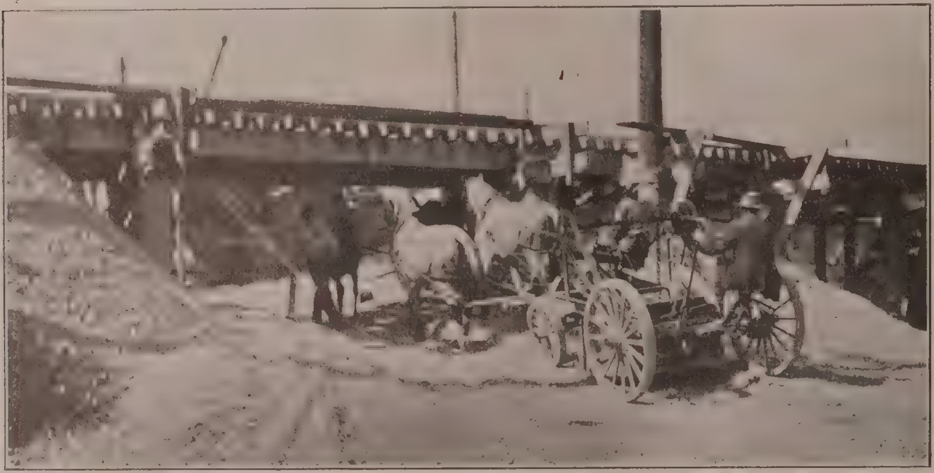
Pouring from Wheelbarrows Cuts Cost of Tar Pavement Filler

BY MIXING tar filler in wheelbarrows, pouring it over the granite-block pavement and scraping it into the cracks with shovels, instead of using a mixing apparatus and the ordinary pouring cans, the cost of placing the filler in the paving being laid on Bridge Street in Brooklyn, New York City, has been greatly reduced. The sand and tar are heated separately. About three pailsful of hot tar are drawn off into a wheelbarrow and the sand is gradually added and mixed in with a hoe. A thicker filler can be used than with the cans, reducing the amount of tar required. With the previous method, employing a hand-operated mixer with revolving paddles and pouring cans, 28 lb. of tar per square yard of pavement was required, and 20 men were employed in the pouring gang. With the present method from 17.3 to 22.6 lb. of tar is required per square yard, and the same rate of progress is maintained with only 7 men.

The work is being done by Fred Hess, subcontractor for the C. A. Meyers Contracting Company, and is in charge of W. W. Thurman.

Use Four-Wheeled Scraper to Handle Aggregate

A FOUR-WHEELED scraper is being used by an Iowa City contractor, who is building a concrete bridge over the Iowa River, to haul aggregate from an interurban trestle over the street approach to the mixing plant, some 300 ft. away. Bottom-dump cars carrying broken stone are run over the trestle and dumped into the street below. The use of the scraper to pick up the stone saved building a bin, for which there was scant headroom, as can be seen from the photograph. Four horses handle the Maney scraper while loading and pull the load up on to a material pile, where it is then handled by slip scrapers to a grizzly through which the material drops into small cars. These are hauled by cable up an incline and dumped into the mixer. William Horrabin is the contractor.



ADVANTAGE TAKEN OF CHANCE TO DUMP STONE FROM TRESTLE BY USING SCRAPER

Well Points Supply Mixer Water in Small Concrete Plant

INCLUDED in the inexpensive concrete-plant layout for a large box factory at East Chicago, Ind., is a well point supply pumped to an ordinary barrel by means of a diaphragm pump, both pump and barrel being elevated for this purpose, as shown in the photograph.

The level of the site was raised several feet with loose, fine sand, making the hauling of concrete materials for the necessary deep concrete walls and piers difficult. In consequence, it was decided to locate the concrete plant at one point and bring the materials from a railroad siding 200 ft. away, over an inclined industrial track, on a trestle about 10 ft. high at the inner end. All sand, stone and brick required in the construction of the work were hauled up this incline in a 4-yd. car, by means of a cable operated by a gasoline-driven hoist placed ahead of the inner end of the incline, the grade being sufficient to return the car to loading position by gravity. This arrangement permitted the sand and stone to be discharged in piles very close to the mixer, and the brick deposited along the incline nearest to the pockets where they were needed.

A 10-ft. Standard mixer was located about 20 ft. away from one side of the trestle. The remainder of the equipment consisted of a hoist with a 4-hp. Novo engine housed on a truck for operating the cable, and another 4-hp. engine mounted and housed on skids midway between the diaphragm pump and an extra hoist, so that the engine could operate either. At the loading switch two cars were shifted at a time by a hand winch and cable, and kept spotted so that material could be shoveled directly into the 4-yd. hopper car without rehandling.

The work was carried out by John F. Rahn, building contractor for the Indiana Box Company.

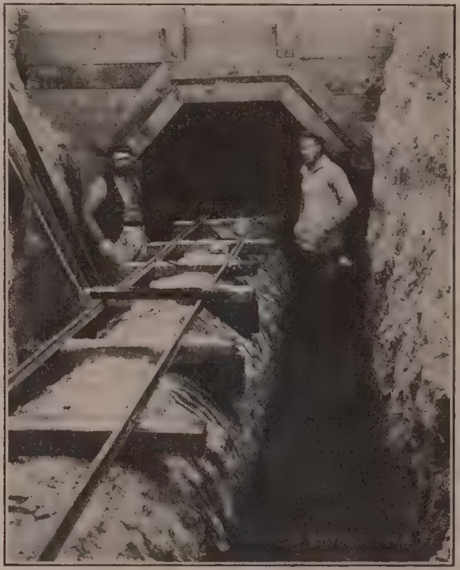
PUMP SUPPLIES MIXER WATER FROM WELL POINTS IN SAND AT RIGHT

Build Track on Top of Pipe to Remove Muck from Tunnel

By A. C. FRANCIS

Operating Department, San Diego, Cal.

IN CONNECTION with repair work being done by San Diego, Cal., to its water system, an accumulation of muck is being removed from the four tunnels on the Otay-San Diego pipe line in cars running on tracks on top of the pipe, one of which is shown in the photograph. For about eight years these tunnels had been allowed to stand just as they were constructed. Their ends became filled with fallen material; they did not drain and small leaks filled the tunnels with water. The water rotted out the lower timbering, sloughed off the sides of the tunnels and caused material to pile up against the lower portion of the pipe. This earth and rotted timber, when mixed with water, formed a muck which caused rapid deterioration in the pipe of all four tunnels.



TRACK LAID ON TOP OF PIPE TO REMOVE MUCK FROM TUNNEL

A break in one of the pipes late in 1915 made immediate attention imperative. The job of rebanding the pipe, mucking out fallen material and retimbering the tunnels was a slow one, as only about fourteen men could be utilized at a time. The muck had to be cleaned out first. To accelerate progress a track was laid on timbers placed on top of the pipe. A small dump car was operated along this track by a hoisting engine located at the entrance of the tunnel.

Small Sewage Plants Predominate

The committee on sewage works operation of the American Public Health Association has made an analysis of sewage-treatment plants in the following fifteen states: California, Illinois, Iowa, Kansas, Maryland, Massachusetts, Michigan, Minnesota, New Jersey, New York, Ohio, Pennsylvania, Texas, Virginia and Wisconsin. The total number of plants reported was 1294. Of these, one-third are designed for populations of less than 500; over one-half for populations between 500 and 10,000; and only 7 per cent for populations over 10,000. Only 29 of the 1294 plants are equipped with complete laboratories, and of this number 17 are in the state of Pennsylvania.

NEWS OF THE WEEK

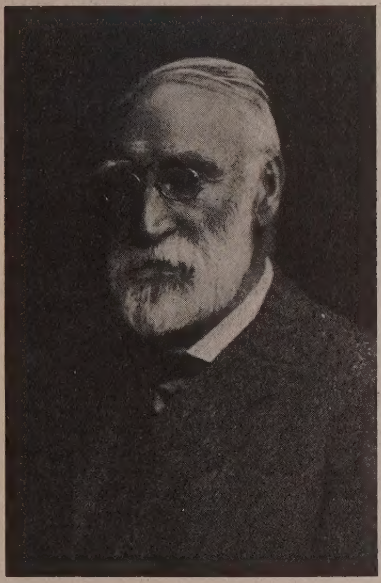
Passing Events in the Civil Engineering and Contracting Fields

Gives $100,000 to Society for Technical Library

James Douglas, President of Phelps, Dodge & Company, Makes Generous Gift to United Engineering Society

Dr. James Douglas, president of Phelps, Dodge & Company, New York City, has presented the United Engineering Society with $100,000, the income from which is to be used in the development and extension of the library. The trustees of the society are endeavoring to secure endowments aggregating $1,000,000 for the purpose of making the collection of engineering literature in the Engineering Societies Building of maximum possible value. Now that the library of the American Society of Civil Engineers has been added to those of the other national engineering organizations in the building, the combined collection forms the greatest source of technical information in the world.

Mining Engineer Gives $100,000 for Engineering Library



DR. JAMES DOUGLAS

Dr. Douglas stands in the front rank of mining engineers. During more than forty years of a constantly active career he has engaged principally in the mining and production of copper, although he has also won acknowledgment of his ability as a railroad executive. He is a native of Quebec, Canada, and received his education at Queen's College, Kingston, Ontario, and at Edinburgh University, Scotland. For several years after graduation he served as professor of chemistry in Morrin College, Quebec. During that period, with the assistance of the late Dr. T. Sterry Hunt, he made a special study of metallurgical treatment of copper ores. These experiments led to the discovery of the Hunt-Douglas processes—an important development in the modern methods in the metallurgy of copper.

Dr. Douglas came to the United States in 1875, at the age of 38, to take charge of the copper works at Phoenixville, Pa. About 36 years ago he became identified with copper industries in the Southwest and northern Mexico. He soon formed the nucleus of the great copper-mining enterprises which, under his management, have taken a place in the first rank of American industry. As president of Phelps, Dodge & Company Dr. Douglas directs the management of the Copper Queen Consolidated Mining Company, the Montezuma Copper Company, Detroit Copper Mining Company, the Burro Mountain Copper Company and the Stag Cañon Fuel Company. In 1887 he was made president of the Arizona & Northeastern Railroad, and since July, 1901, has been president of the El Paso & Southwestern Railroad, which took over the Arizona & Southeastern and other lines in Arizona and which, in 1905, absorbed the El Paso & Northeastern. He is also president of the Nacozari Railroad.

He is a member and has twice been president of the American Institute of Mining Engineers. He is also the author of several books, among which are "Canadian Independence," "Imperial Federation and Annexation" and "Untechnical Addresses on Technical Subjects," and has contributed extensively to the technical press.

New Shipbuilding Works at San Francisco

Union Iron Works Enlarges Plant to Handle $60,000,000 Government Contracts—$20,000,000 for Improvements

Officials of the Union Iron Works of San Francisco announced Nov. 11 that 125 acres of land adjoining the present plant at Alameda had been purchased and that improvements to cost about $20,000,000 will be undertaken at once. This increase in capacity is necessary to provide facilities for handling recently awarded contracts, chief among which are those for the government, which will amount to a total of about $60,000,000.

The new plant, it is said, will be equipped with a 250 x 850-ft. plate shop, ten commercial slips for building vessels up to 15,000 tons, slips for building submarines, two slips for building large battle cruisers and a complete plant for building Diesel and semi-Diesel engines. The large floating drydock which is now being built at Hunters Point will be towed to the Alameda works when completed.

Government contracts, the report continues, include two battle cruisers, one scout cruiser and ten submarines. Possibly four more battle cruisers will be built at a cost of about $15,000,000 each. In enlarging its plant the company is inaugurating a scheme for domiciling the workmen who will be engaged there. Plans for a system whereby a force of 6000 workmen will be assisted in buying their own homes near the plant are being prepared.

18-Mile Tunnel to Be Driven for New York Water Supply

An 18-mile tunnel, which will be one of the longest in the world, is to be driven between Prattsville, N. Y., on Schoharie Creek, and a point on Esopus Creek near Shandaken, through one of the main ranges of the Catskill Mountains. The tunnel will be contracted for next spring by the Board of Water Supply of New York City. It will supply the necessary 250,000,000 to 300,000,000 gal. daily to operate the Catskill aqueduct at full capacity.

The tunnel is to be horseshoe shaped, about 13 ft. in diameter, and lined with concrete. There will be seven or eight shafts, varying in depth from 100 to 640 ft. The distance between shafts will vary from about 10,400 to 14,200 ft. The dam to form the Schoharie reservoir will be located at Gilboa.

Discuss Proposed Motor-Truck Legislation

Motor-Truck Men Oppose "Discriminatory Rules" at Special Hearing in Albany—Only Two Highway Engineers Present

As a preliminary to New York State legislation regulating the operation of motor trucks, which it is planned to put into effect on Jan. 1, 1917, a hearing before a special commission, consisting of the state highway commissioner, the state engineer and the state superintendent of public works, was held in the state capitol at Albany Nov. 21. There were present representatives of the Motor Truck Club of America, manufacturers and users of trucks, trailers and tires, and only two highway engineers, the audience numbering about fifty. Commissioner Edwin Duffey of the state highway department presided at the session, and with him sat William B. Landreth, deputy state engineer, and General Wotherspoon, superintendent of public works. The purpose of the hearing, as outlined by Mr. Duffey, was to receive suggestions from those who would be affected by the proposed new law, in order that the commission might have at hand all data which would aid in fixing an equitable new schedule of fees for motor trucks.

Claim Measure Discriminates

Speaking for the Automobile Chamber of Commerce of the United States, Thaddeus T. Terry, its counsel, objected to the proposed measure as a piece of discriminatory legislation, inasmuch as it placed a burden of taxation upon the motor truck without requiring anything from the horse-drawn vehicle, which, he claimed, was responsible, in part at least, for the destruction of highways. He asserted that the constitutionality of any such regulation was open to grave doubt. "But even if the commission proceeds with the fixing of this schedule of motor-truck fees," he said, "it is attempting an impossible task. The commission is instructed to base the new tax upon the amount of wear and tear on highways caused by motor vehicles of various types. The scientific determination of a just tax on this basis is not feasible." Roads, Mr. Terry held, should be considered purely as a governmental function, like a police or fire department. Their upkeep, therefore, he argued, should not fall upon a special class of users but should be paid for out of general funds.

Roderick Stephens, president of the Motor Truck Club of America, offered to the commission a number of concrete suggestions. Among them were that a competent automobile engineer be employed by the commission to aid it in the technical phases of its work; that a preliminary draft of the measure be made public before its final adoption; that another hearing be held in New York City; and that it should be realized that the owners of motor trucks were not the only ones who benefited by the operation of these vehicles. He characterized the proposed rules as discriminatory.

Must Get Accurate Data

George H. Pride, another Motor Truck Club member, urged the need of accurate data on road wear before final action is taken. One of his points was that trucks operating exclusively in a city such as New York should not be compelled to contribute to the maintenance of state highways which these city vehicles never used. The same stand was taken by counsel for the Fifth Avenue Coach Company of New York City. Of 16,000 trucks registered in New York State, according to Mr. Pride, only from 10 to 15 per cent ever use the state highway system. All their work is done on city pavements. Speaking of the proposed tax on motor trucks Mr. Pride said: "If we are charged more we cannot absorb it but must pass it on."

A. F. Masury, a motor designer, spoke of the technical features involved in the proposed law. Consideration should be given, he said, to whether or not the vehicle is provided with springs and what part of the load is borne by the springs and what part is on the "dead axle."

That trailers should not be compelled to have steel tires was another of the arguments of the motor truck men.

A. Jackson Marshall, representing the electric vehicle interests, maintained that the various differences between electric trucks and gasoline trucks should receive due consideration.

Eugene W. Stern, chief engineer of highways, Borough of Manhattan, New York City, cited the damage done to granite-block and sheet-asphalt pavements by an excessively heavy steel-tired tractor-trailer outfit used on the subway work. New York City, Mr. Stern said, is now framing an ordinance governing the use of city streets by motor vehicles.

Plan $5,000,000 Hotel

Plans for an apartment and hotel building in Chicago to cost $5,000,000 are being prepared by Marshall & Fox, architects, according to an announcement made last Saturday by the Drake Hotel Company. It is stated that the structure will occupy the southeast corner of the Lake Shore Drive and Lincoln Parkway. This land, formerly owned by the Potter Palmer estate, is 216 x 400 ft.

Contractor Sent to Penitentiary

Thomas Kelly, contractor, of Winnipeg, Canada, was sentenced Nov. 19 to serve two and one-half years in the penitentiary, according to reports. He was convicted at the summer assizes on charges arising from alleged fraudulent dealings in connection with contracts for the Manitoba Parliament building.

Peoria (Ill.) Viaduct Nearly Completed

The steel viaduct at Peoria, Ill., over the tracks of the Chicago, Burlington & Quincy, the Chicago, Milwaukee & St. Paul and the Minneapolis & St. Louis railroads is expected to be completed by Jan. 1.

John Fritz Medal to Be Presented to Dr. Elihu Thomson

The John Fritz Medal, which was awarded last January to Dr. Elihu Thomson for achievements in electrical inventions, in electrical engineering and industrial development, and in scientific research, will be presented at a meeting to be held in Boston Dec. 8. The presentation will take place in the Central Lecture Hall of the new buildings of the Massachusetts Institute of Technology.

Cut Bridges to Allow Dredge to Pass

Two bents, comprising a section 46½ ft. wide in the Stone Avenue bridge, across the Lake Washington Canal in Seattle, were cut Nov. 12 and the government dredge was permitted to pass. Early in the morning of Nov. 15 the Latona Avenue bridge was closed to traffic, an operation similar to the one at Stone Avenue was performed and the dredge resumed its voyage. The work at the Stone Avenue structure consumed more time than was originally planned. The street department deemed it advisable to cut the piling about 9 ft. below the water and to replace the ends on their former resting places after the dredge had passed. This plan was abandoned. The piles under water were pulled and new ones driven in their places.

General Dan C. Kingman Is Dead

Passed Away After Forty-one Years of Service—Three Years as Head of Corps of Engineers, U. S. A.

Brig.-Gen. Dan C. Kingman, Corps of Engineers, U. S. A., formerly chief of engineers of the army, died Nov. 14 at Atlantic City, at the age of 64. For two and one-half years—October, 1913, to March, 1916—he was in command of the Corps of Engineers and in charge of the Engineer Department, after which he was relieved from active service.

General Kingman was born in 1852 in New Hampshire. When he was graduated from West Point in 1875 he stood second in his class. For three years thereafter he served with the engineer battalion at Willets Point, N. Y., and during the next three years was assistant professor of engineering at the academy. Following that he was assigned to duty in Western states. He spent two years at Omaha, four years in charge of improvement of Yellowstone National Park and was also a member of the committee to examine the penitentiary at Sioux Falls, S. D. His transfer to New Orleans late in 1886 gave him his first experience on river and harbor work. That his work there was of a high character is evidenced by the message he received from the Louisiana legislature thanking him "for the splendid services rendered our state during the high water of 1890."

Former Chief of Engineers, U. S. A., Is Dead

Photo by Harris & Ewing, Washington

BRIG.-GEN. DAN C. KINGMAN

In that year General Kingman was transferred to Oswego, N. Y., where for five years he was in charge of the defense works on the lake shores of New York and various harbor improvements. At Chattanooga, where he was stationed from 1895 to 1901, and at Cleveland, from 1901 to 1906, he had charge of harbor improvements, reported on several large bridge projects and was a member of the board to consider and report upon proposed methods for driving a tunnel under the Detroit River.

Returning to the South in 1906, with headquarters at Savannah, Ga., General Kingman immediately directed his energies toward effecting many improvements on defense works and harbors in that territory. His appointment to command of the Corps of Engineers and the Engineer Department came Oct. 10, 1913. His retirement from active service went into effect in March of this year.

$20,000,000 Factory Community for Chicago

More Than Eighty Buildings to Be Erected on 100-Acre Plot on Thirty-ninth Street, Between Ashland and Western Avenues

Establishment of a model factory and warehouse community in which there will be constructed more than eighty buildings that will represent an ultimate expenditure of approximately $20,000,000 is under way on the southwest side of Chicago. The community will form part of the central manufacturing district and will be located on a tract of 100 acres on Thirty-ninth Street between Ashland and Western avenues.

Two tunnel systems, which will cost approximately $150,000, are under construction. The site of the community is that which about two years ago had been selected as the location of a produce terminal, to which the South Water Street merchants were to be brought, but which plan has been abandoned.

$1,200,000 Freight Terminal

The first of the community's buildings will be a six-story and basement cold storage warehouse now being constructed on Thirty-ninth near Robey Street. Excavation work on the site of the new union freight station and loft building has been started. The building will be of brick and concrete construction, will cover a plot about 600 x 500 ft. and will cost more than $1,200,000.

Construction work upon the new central power plant for the community will be begun within the next thirty days. The structure will contain sprinkler tanks with a capacity of more than 200,000 gal., high-pressure pumps, hot-water heaters, coke and ash conveyors and other modern facilities. This building will cost about $250,000.

Commerce Body to Solve Sewage Problem of Chicago

Co-ordination between the city of Chicago, the Sanitary District, the state legislature and Congress, as related to Chicago's sewage problem and in directing an intelligent opinion locally and nationally, is the aim of the Chicago Association of Commerce. At a recent preliminary conference between association committee members and representatives of the Sanitary District, including George M. Wisner, chief engineer, and Langdon Pearse, division engineer, the following points were developed:

The association could aid in giving the authorities at Washington a correct impression of the Chicago situation.

Informal continuance of the discussion of the problem should wait upon the decision in the case now pending before Federal Judge Landis, with reference to the diversion of water for the drainage canal.

The association could aid in having other lake cities rightly understand the question of water diversion.

Effort should be made to bring about the construction of compensating works in the St. Clair and Detroit rivers with a view to maintaining present lake levels.

There should be some supplementary methods of sewage disposal even though Chicago is permitted to take all the water for dilution purposes now required under the present system. Should the decision of the federal court be adverse to the desires and practice of Chicago in sewage dilution, there would probably be allowed a reasonable time in which Chicago might decide upon the nature of supplementary disposal works and in which to construct the same.

It is important that a clear understanding be reached as to the conditions which are to be brought about in the drainage canal and the Chicago River.

It is desirable that the Sanitary District should make provisional arrangements for possible sewage-disposal plants.

It should be impressed upon the Washington authorities that the main interest of the Sanitary District is in the problem of sewage disposal and the protection of the water supply of Chicago.

It is a question whether the people of Chicago are willing to pay for methods of sewage disposal other than dilution.

Engineering Society Activities

Western Society of Engineers at its Dec. 4 meeting at Chicago will hear an outline of the work of the Naval Consulting Board by Bion J. Arnold.

Concrete Institute met Nov. 23 in Westminster, England, for the first time this year. The feature of the evening was the presidential address by F. E. Wentworth-Shields. At the Dec. 21 gathering Prof. Henry Adams will discuss pile driving and the supporting power of piles.

Engineers' Society of Western Pennsylvania's nominating committee has selected the following members for office: President, A. L. Hoerr; vice-president, George H. Neilson; treasurer, A. E. Frost; directors, E. W. Pittman and George H. Barbour.

Steel Treating Research Club held a meeting Nov. 21 in the rooms of the Detroit Engineering Society. Richard P. Brown, president of the Brown Instrument and the Keystone Electrical Instrument Companies, spoke on "Pyrometers—Past, Present and Future." F. F. Beall, vice-president of the Packard Motor Car Company, will address the club in January.

Engineers' Society of Northwestern Pennsylvania held its monthly meeting at the Engineers' Club, Scranton, Nov. 16, adjourning to the board of trade auditorium for the lecture by G. H. Hill, assistant engineer of the railway and traction department of the General Electric Company. The electrification of the Chicago, Milwaukee & St. Paul Railway was his subject. The development of transportation and the various steps in the construction of a modern electric locomotive were picturized by slides and "movies."

Engineers' Society of Pennsylvania, Harrisburg, heard Samuel T. Wagner, chief engineer of the bridge department of the Philadelphia & Reading Railway, lecture on grade separation at the Nov. 17 meeting. The work done in Philadelphia several years ago was detailed by Mr. Wagner. F. Herbert Snow, chief engineer of the Pennsylvania Public Service Commission, introduced the speaker. In his introductory remarks Mr. Snow mentioned the 1200 grade crossings in Pennsylvania which he hopes to eliminate gradually.

What Engineers and Contractors Are Doing

G. W. Smith has resigned as architectural engineer for the Hodgin Construction Company, of St. Paul, to enter the service of the Ford Motor Company. He is now at Kansas City superintending the construction of the new power plant being built in connection with the new assembly plant in that city.

R. Z. Kirkpatrick has been transferred from the Panama Canal, where he was assistant chief hydrographer, to the Bureau of Yards and Docks, Washington. In his new work Mr. Kirkpatrick will be engaged in structural-steel design. After graduation from the Iowa State College of Agriculture and Mechanics in 1907 he spent several years with Western steel companies and a year on irrigation work. Since 1910 he has been on the Panama Canal, first as draftsman in the office of the chief engineer at Culebra and later as junior engineer on the Pacific locks. He was appointed assistant chief hydrographer in January, 1915.

A. R. Ross has resigned as engineer in charge of the St. Louis Municipal Bridge to enter the contracting field. He is now at Murphysboro, Ill., erecting two steel bridges and six pile-and-timber trestles for the Murphysboro & Illinois Railway, a new traction line connecting Murphysboro with Carbondale. S. A. Robertson and G. L. Miller are associated with Mr. Ross under the firm name of Ross, Robertson & Miller.

Olaf Laurgaard, consulting civil engineer, of Portland, Ore., was recently elected by an overwhelming vote as a Multnomah County representative to the state Legislature. Mr. Laurgaard is well known throughout the Northwest due to his activities on various irrigation projects. This is his initial appearance in the political field. He is 36 years old, a graduate of the University of Wisconsin, and has been a resident of Portland since 1910.

J. M. Dougan, formerly president of the Sound Construction Company, Portland, Ore., is now engaged in the contracting business as the J. M. Dougan Company. Offices of the concern are maintained in the former offices of the Sound Construction Company in the Couch Building. The firm recently secured a contract for building the $75,000 court house at Grants Pass, Ore., for Josephine County.

C. E. Paris has been appointed general manager of the Imperial Irrigation District, with headquarters at El Centro, Cal. During the last ten years Mr. Paris has been general superintendent of the W. F. Holt properties with headquarters at Holtville, Cal. The Holt properties include the Holton Power Company, the Holton Interurban Railway, the Imperial Valley Gas Company and the Coachella Valley Ice & Electric Company.

R. P. Moore has been made general superintendent of the Holton Power Company and the Holton Interurban Railway at Holtville, Cal., to succeed C. E. Paris, whose resignation is noted elsewhere in this issue.

G. C. Habermeyer was recently appointed assistant engineer of the Illinois state water survey.

A. L. Crissinger has been made state highway superintendent of Beaver County, Pennsylvania. He has been in the employ of the highway department for three years.

J. W. Frazier has resigned as road superintendent of Potter County, Pennsylvania, to enter private business.

A. B. Howard has been made general foreman of highways in Jefferson County, Pennsylvania. The position of superintendent, made vacant by the promotion of N. M. Dorwart, will not be filled at present.

Caleb Berry, formerly city engineer of Centralia, Wash., has been engaged to make preliminary surveys for a proposed irrigation district in Ford's and Waunch's prairies, near Centralia.

S. E. Junkins & Company, of Montreal, who recently secured the contract for the extension of the Canadian Pacific Railway pier at the foot of Granville Street, Vancouver, B. C., will open an office in that city at an early date.

A. Leckie, formerly division engineer of the Arkansas Western Railway, has been appointed to a similar position with the Kansas City Southern Railway. He will have headquarters at Kansas City.

Charles A. Lemmon has resigned as chief engineer of the Butte, Anaconda & Pacific Railway to become assistant to the general manager of the Anaconda Copper Mining Company.

N. M. Dorwart was recently promoted from the superintendency of Jefferson County to a similar office in Potter County, Pennsylvania. Mr. Dorwart is a graduate of Franklin and Marshall College and has been with the Pennsylvania highway department about five years.

Monroe L. Patzig has resigned as general manager of the Monarch Engineering Company, Des Moines, Iowa, to engage in private consulting practice. He will specialize in paving work.

E. L. Williamson, who was shaft engineer on the Newark side of the tunnel under Newark Bay, built as part of the Passaic valley sewer system, is now working on a 1-mile trunk sewer in the Borough of the Bronx. He has been with the New York & New Jersey Construction Company for the last two years.

Obituary Notes

Frank O. Sinclair, consulting engineer, of Burlington, Vt., died Nov. 15 in that city. Since 1914 he had been city engineer, and at the time of his death was consulting engineer to the Public Service Commission of Vermont. Mr. Sinclair was born in 1860 in Burlington and was graduated from the University of Vermont in 1882. After graduation he went to Leavenworth, Kan., to become assistant city engineer. He next turned his attention to railroad work and in 1884 was made assistant engineer for the Missouri Pacific Railway. After a year with that road he went to the Chicago, Rock Island & Pacific Railway as division and assistant engineer. Two years later found him principal assistant engineer in charge of construction of the Atlantic, Knoxville & Northern Railway. He remained with that road until 1890, following which he was for short periods employed by the West Virginia & Pittsburgh Railroad and the Ducktown Mineral Railway. Mr. Sinclair returned to his native city early in 1893 to become chief engineer on the construction of the Winooski & Burlington Electric Railway. Since then he has been employed by several railroads and other organizations in Vermont in a consulting capacity. He was past president of the Vermont Society of Civil Engineers.

Fred E. Weymouth, head of the Weymouth Construction Company, of Seattle, died recently at the age of 56. Mr. Weymouth had lived in Seattle for thirteen years, going there from Tacoma, where he has resided twenty years. During four years of his residence in Tacoma he was division superintendent of the Northern Pacific Railway. The Weymouth Construction Company is one of the largest contracting firms in the Northwest.

John Robert Moore, a civil engineer, who was for many years connected with the New Jersey Central Railroad, died recently at his home in Merrick, L. I. He was graduated from Norwich University and was for the last twenty-five years with the New York Department of Highways.

Civil Service Examinations

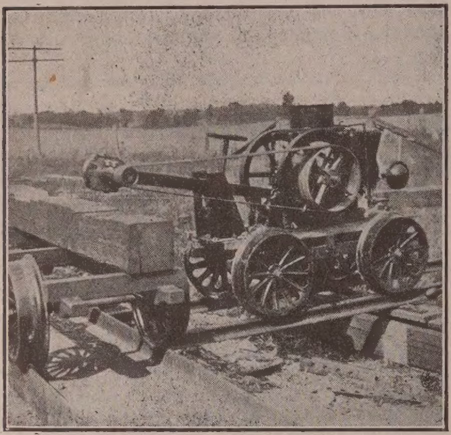
United States—Examinations will be held Dec. 13 and 14 for assistant engineer inspector of weights and measures, salary $1,000 to $1,600. Other examinations will be held at the same time for structural engineer and draftsman, salary $1,600 to $1,800, and for laboratory apprentice, salary $480. Examinations will be held Dec. 11 for designing engineers, Navy Department, salary $10 to $15 per day. Form 1312 should be filled in.

Examinations Previously Announced

Date		See Eng. Rec.
Dec. 2.	Junior assistant engineer, junior electrical engineer and supervisor dredging plant, New York State	Nov. 18
Dec. 11.	Civil and sanitary engineers, Massachusetts	Nov. 18

Motor-Driven Adzing Machine Saves Labor

Due to the scarcity of labor, the machine illustrated may be of more than usual interest to contractors. It is portable, requires one man to operate and is said to do more work than six mechanics. It is especially adapted for framing bridge ties and guard rails for railroad bridges. A gasoline engine mounted on a small car of 2-ft. gage has hinged to it an adjustable arm supporting a cutter head at its outer end. This arm, belted to the engine, is adjusted for depth of cut by a vertical screw. The material is carried at right angles to the machine on a longer car of 2-ft. gage.



ADZING MACHINE SAVES LABOR

To proceed with the work, the arm is adjusted to give the proper depth of cut and clamped in that position. The small car is moved back and forth by a lever clamped to the forward wheel. This gives the cutter head a direct horizontal movement over the work. Each movement forward and backward gives a 2-in. cut each way. As those cuts are made, the material car is moved 2 in. Thus any width or depth of cut can be made.

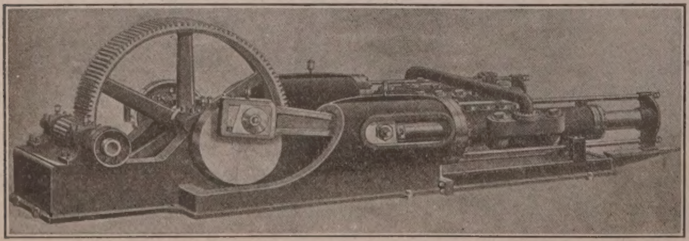
The machine was invented by J. E. Toohey of Grand Rapids, Mich.

Hydraulic Pump Supplies Large Volume at High Pressure

The pump illustrated is a recent addition to the line of high-pressure hydraulic pumps built by the Hydraulic Press Manufacturing Company, Mount Gilead, Ohio. It is of the horizontal, four-plunger type and designed to fill the requirements for a simple, heavy duty, hydraulic pump for supplying a large volume of water or other fluid against a high pressure.

This pump is designed so that it may be equipped with sixteen different sizes of plungers ranging from 1⅜ to 5 in. in diameter, advancing by quarter inches. The water cylinders are made of forged steel for the highest pressures. For the medium pressures—1500 to 2900 lb. per square inch inclusive—cast steel is used; for the lowest pressures the cylinders are semi-steel. The pressures range from 700 to 9500 lb. per square inch, and the water capacity from 24 to 326 gal. per minute. All sizes have bronze valve seats and bronze or nickel steel valves.

This pump is built for motor drive, requires 150 hp. to operate and is equipped with a flexible shaft coupling for motor connection. The stroke of the plungers is 16 in. and the two cranks are set at 90 deg., so that a uniform flow may be obtained. The frame or pump bed consists of two heavy castings securely bolted together. The crosshead guides and main bearing containers are machined in this frame to insure perfect alignment and give rigid construction. The pump occupies a floor space about 19 by 7 ft.



PUMP EQUIPPED WITH SPUR GEAR AND PINION CAN ALSO BE FITTED WITH HERRINGBONE GEAR AND PINION—OPERATED BY 150-HP. MOTOR

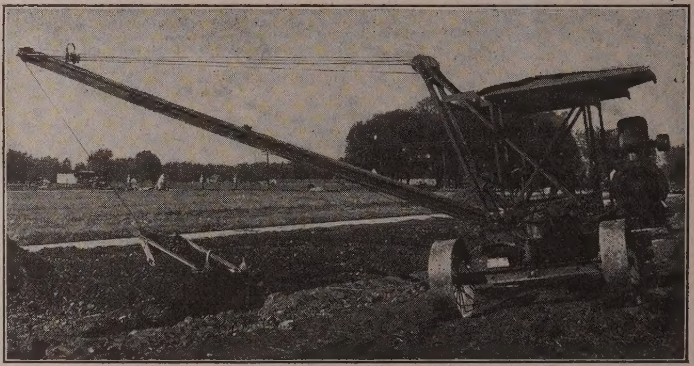
Error in Reporting Patent Case Decisions

It was reported in the Engineering Record of Nov. 4, page 576, that two patent decisions had been handed down recently by United States circuit courts of appeals. The statement was in error. Both cases (Turner vs. Lauter Piano Company and Turner vs. Deere & Webber) were in United States district courts. The decisions therefore are appealable; and the subsequent statement in the news item, that "the decision would seem to settle for all time claims which Mr. Turner has made since his earlier losses in the courts," was without foundation.

Backfilling Machine Used as Dragline Excavator

With a new heavy backfilling machine having corduroy grip traction and extensible boom, dragline operations on a small scale were carried out to remove black earth from the spoil of a sewer trench to adjoining vacant lots for fill. This work was carried out in building sewers in Chicago by Alphonso Scully, sub-contractor to W. F. Healy, with a 7½-ton Pawling & Harnischfeger backfilling machine recently placed on the market in this large size. In operating as a dragline the material was pulled over to one side of the 26-ft. street in front of the self-acting scraper, 4 ft. wide.

The 22-ft. timber boom, which was extended to 30 ft., is arranged to swivel 4 ft. on either side of the center line to allow the scraper to be moved to this extent without moving the machine. The photograph shows the regular backfilling operation, filling about 700 ft. per day of 24-in. trench 10 ft. deep.



ONE MAN OPERATES HEAVY BACKFILLING MACHINE WHICH IS FITTED WITH DRAGLINE EXCAVATOR AND CORDUROY GRIP TRACTION

Completely Equipped Plant to Handle Reinforcing Steel

As an indication of what a staple line steel bars for reinforced-concrete is becoming, a recent announcement by the Republic Structural Iron Works Company, of Cleveland, is of special interest. That company has taken over the entire plant of the Avery Stamping Company, covering 100,000 sq. ft.

On this site will be installed a complete plant for fabricating and shipping bars for concrete. With this plant in operation, it is said that a contractor can place his order for a complete building. The steel can be fabricated, placed in storage and sent to the job as required. It is said that facilities will be available for handling 4000 tons of steel.

Business Notes

Standard Scale & Supply Company has removed its Philadelphia office and warerooms to 523 Arch Street. The new quarters permit storage of the concrete mixers, engines, trucks and repair parts handled by the company.

Jamestown Shale Paving Brick Company of Jamestown, N. Y., has become a licensee of the Dunn Wire-Cut Lug Brick Company of Conneaut, Ohio.

Lynn B. Dudley has been appointed advertising manager of the Federal Motor Truck Company to succeed George W. Cushing, who recently went to the Hudson Motor Car Company. Mr. Dudley has had twelve years' experience in the editorial and advertising departments of newspapers. For three years he was connected with the Campbell-Ewald Company, advertising agents.

Edward T. Hendee, secretary of Joseph T. Ryerson & Son, Chicago, died Nov. 12 in Minneapolis.

D. Fukuzawn, of the Meishosha Company, Tokio, Japan, is seeking American agencies on building materials and machinery for paper mills. His address is care of the Standard Paint Company, Woolworth Building, New York.

Trade Publications

The following companies have recently issued trade literature:

Buffalo Forge Company. Catalog, 6 x 9 in.; 54 pages; illustrated. Devoted to "Armor Plate" punches and shears.

Greenfield Tap & Die Corporation, Greenfield, Mass. Catalog 67, 4¾ x 7¼ in.; 270 pages; illustrated. Gives sizes and prices of cutting tools.

Templeton, Kenley & Company, Toronto, Canada. Catalog 216, 6 x 9 in. Describes various types of Simplex jacks and their uses.

Spray Engineering Company, Boston. Bulletin 310, 3½ x 6 in.; 10 pages; illustrated. Describes the "Spraco" paint gun.

Portland Cement Association, Chicago. Booklet, 9 x 6 in.; 24 pages; illustrated. Deals with the use of concrete as an alley-paving material.

Mitchell-Tappen Company, New York. Bulletin 14, 4¼ x 9½ in.; 12 pages. Illustrates and describes applications of "Standard metal gaging."

Chicago Pneumatic Tool Company, Chicago. Bulletin 34-Z, 6 x 9 in.; 20 pages. Describes steam-driven single compressors.